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Psychological Review

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THE PSYCHOLOGICAL REVIEW

ADVANCE ADAPTATION IN BEHAVIOR

BY S. BENT RUSSELL

St. Louis, Mo.

In the study of behavior we find that the animals that have the most highly organized nervous systems are the best adapted to changes in their environment. When we observe behavior that is adapted in advance to changes in the environment, we call it purposive behavior. It is thought that from the behaviorist point of view it would be more consistent to call it 'advance adaptation,' but purpose and purposive are very convenient expressions. We shall therefore use these terms in this discussion. It is to be understood, however, that this does not mean that we recognize consciousness as a factor in the operations.

A study of the broader aspects of purpose in behavior has recently been presented in a series of articles by Prof. Howard C. Warren.[1] The following extracts from them will serve in some measure as a basis for our arguments: "For some biologists purposive activity remains an insuperable obstacle to the complete acceptance of the mechanistic standpoint." "The vitalists . . . assert that a nonmechanistic factor . . . is needed . . . in purposive phenomena." "It remains to be seen whether the mechanistic interpretation is *adequate* to account for the purposive character of behavior."[2]

Let us consider now what part of purposive behavior can be traced to nervous mechanisms. Recent writers on behavior have shown how we may account for such behavior

[1] Howard C. Warren, 'A Study of Purpose,' *J. of Phil., Psychol., &c.*, 1916, 13, Nos. 1, 2 and 3.

[2] *Loc. cit.*, pp. 31 and 32.

as performing a definite series of movements. They have shown that each movement of the series excites kinesthetic impulses which follow certain paths in the nervous system because those paths have been opened up, as it were, by frequent or recent use. In this way these impulses excite the next movement of the series.[1]

In order to provide a good foundation for a discussion of the subject before us, let us try to get a further understanding of such behavior as performing a definite series of movements and of the nerve mechanisms that account for such behavior. As already stated, movements make impulses that excite other movements. Such impulses play a most important part. In many cases impulses from the environment assist in exciting the particular movement. When a man takes his accustomed morning bath, he makes movements in a definite order, each being prompted by the joint action of the environment and the preceding movements through the medium of the nerve paths.

When the movements are repeatedly made in a certain order, the lot may be termed a memorized series. The nerve paths or fibers that determine the movements may be distinguished as association fibers. They are developed by practice. Movement *A* may send kinesthetic impulses through association fibers to the muscles that cause movement *B*, or movement *A* may make a change in the environment and the change may affect some receptor which sends impulses that provoke movement *B*. In either case we may say that a counter signal from movement *A* excites movement *B*.

Each movement of a series is excited by a counter-signal and each produces counter-signals for movements to follow. That is not, however, the whole story. Let us suppose that a soldier has been trained to make a series of movements which we will call *A B C D E F G*, each letter representing a movement. Counter-signals from movement *A* will directly cause movement *B*. Moreover, counter-signals from *A* will tend to excite *C* and more faintly *D* and still more faintly *E*,

[1] Watson, John B., 'Behavior,' New York, 1914, p. 275.

and so on. In the same way each movement will partially excite every movement that follows in its train. Now when, for example, a counter-signal from *A* reaches the nerve path leading to the motor ending for *D*, it in some way facilitates the later impulse from *C* to *D*. It opens the common path or lowers the resistance so that movement *D* is thereby insured.

To explain further, we will assume that there is a dual common path that is open to impulses from *A* and *C* only and which leads to the motor ending for movement *D*. This path has been developed further each time an impulse from *C* has followed in the wake of an impulse from *A*. As a result of this path-making, an impulse from *A* leaves the path so wide open for a time that an impulse from *C* can effectively reach the motor ending for movement *D*. This explains why movement *D* follows after *A* and *C*. In like manner each other movement makes counter-signals that facilitate each movement that follows in its train.[1]

To express it another way, each movement makes a certain impression on or change in the nervous system which takes part in determining what movements shall follow. This impression must last a considerable time, but gradually diminishes. Let us now suppose that these impressions on the nerve fibers remain after the whole performance is completed and last until the performance is repeated. We see that new impressions will be imposed on old ones.

In passing on these theories of nervous operations it is well to remember that the simplest movement is caused by the contraction of one or more muscles and that each muscle is a group or community of muscle fibers. Leading to these muscle fibers is a nerve made up of nerve fibers. Many of these fibers are motor fibers. A single motor fiber may branch to a number of muscle fibers. We know, of course, that a muscle contracts with varying strength when stimulated by impulses coming through the nerve. On the other hand, physiologists have made experiments in recent years

[1] A discussion of this theory is given by the writer in an article on 'Compound Substitution in Behavior,' PSYCHOL. REV., 1917, 24, 62–73.

which indicate that in an individual nerve fiber the size of the propagated disturbance does not vary with the strength of the stimulus.[1] In this connection, the great number of nerve fibers that may be concerned in each operation has an important bearing.

Modern behaviorist theories of nervous mechanisms rest on the principle that recency and frequency of previous excitations determine the extent that the resistance is lowered in a given nerve path, to the passage of an impulse. It may be noted here that a memorized series is learned by one lesson after another. In the first lesson the situation is more or less new or unfamiliar. With each additional lesson, of course, the situation becomes more familiar. In childhood man learns a vast number of movement series, *i. e.*, he acquires numerous habits. In maturity his behavior is largely governed by habits. Language habits and other social habits are important factors in man's daily life. In new situations behavior may be largely instinctive, in familiar situations habit governs. Let us put it down as an established fact that such behavior as performing a memorized series of movements can be satisfactorily explained in terms of nervous mechanisms made up of association nerve fibers.

The object of this article is to show that purposive behavior can just as well be explained in the same terms. At least, we can show that some forms of behavior that would be considered purposive can be so explained. We shall begin our demonstration by pointing out what behavior may be termed purposive. We shall then call attention briefly to the correspondence in the growth of purposive behavior with the growth of habits and language movements, and movements associated with measurement of time. The part played by teaching will be pointed out. The effect of reward upon actions will be discussed. Recognition of purpose will be considered. We shall then take up the development of forethought, so to speak. It will be pointed out that memorized movement series and series of incipient movements may be combined so as to provide for and give rise to purposive behavior.

[1] Adrian, *J. of Physiol.*, 1914, 47, 460–474.

In looking back over a series of behavior phenomena, we see that some of the changes in the environment were provided for in advance just as "Coming events cast their shadows before." For example, we see that Mr. Gray, who went out for a walk at three o'clock, at starting borrowed an umbrella. At four he returned in the rain, sheltering himself with the umbrella. We see that the act of borrowing the umbrella at three was adapted to the need for shelter at four. It is therefore advance adaptation or in common terms purposive behavior. Let us take another case. We see that Dick said to Ralph, "I want to get a canoe and go paddling. Will you come too?" Ralph replied, "Yes, I will go with you," and later on we find them on the water in their canoe. The question and reply, we find, were adapted to later conditions when they arrived at the dock. So this, too, is purposive behavior. Let us take a third case. A boy saw a strange dog and stooped and picked up a small stone. The dog saw the movement and dashed around the corner of the house so that he escaped the flying missile. We see that the dog's action was adapted in advance to the boy's act of throwing. This, too, is then purposive behavior. To compare with this, let us think of a boy that slipped and fell on a briar and hurriedly got up. This is not purposive behavior, as there is no anticipation in it.

We may here observe that the acts of an educated man are usually compounded of purposive and nonpurposive elements. It is in the educated man that we find advance adaptation the most highly developed. The best measure of the degree of advance adaptation, it is thought, will be found in the precision and definiteness of the correspondence of the behavior with the ensuing changes in the environment. Let us call this, for convenience, the degree of purpose. As an illustration, a man who composes the score of a grand opera is giving a good example of behavior having a high degree of purpose. No argument is needed to show that in the human species, the degree of purpose develops side by side with the accumulation of knowledge, *i. e.*, with the formation of memory associations. The same rule seems to

hold with the brutes. The fox that has been hunted before is harder to capture because, as we say, he is more wary. On consideration, we find good reason to believe that in race development and in individual development, the growth of purposive behavior has been in proportion to the growth of habits.

Let us now enquire briefly into the effect of language upon purposive behavior. In considering adaptation in animals we must take account of their social environment as well as of their physical environment. The individual must adjust his behavior to meet the actions of others of his species and also those of his natural enemies and it may be those of the creatures he preys upon. If the animal has even the most primitive nervous system, it will be affected by the movements of other animals. Natural selection brings about the evolution of language habits in many species. The sense of hearing must have been developed mainly by the demands of social environment. By means of sound waves there is communication between animals so that the movements of one individual will excite a response in another individual. When a quail is flushed, the sound of his wings provokes the flight of the rest of the covey. The senses of touch, smell and sight are also used for communication. It is probable that sign language is much used in many species. Dogs and cats show by the movement of their tails what their feelings are and no doubt their companions are observant of the movements and are guided accordingly. When a big dog growls at little dogs, he says in dog language, "Keep away, or I will bite you," and when the little dogs retreat, they say with their tails, "Come away or he will hurt us." On consideration, we find that the evolution of language habits must have proceeded side by side with the evolution and differentiation of species and with their social evolution. In the individual we find that language habits develop from birth up. In this connection let us note that nerve paths are lines of communication from sense organs to muscles and from muscles and joints to other muscles. Let us note furthermore that by means of distance receptors the lines

of communication are extended into the environment. Language movements serve for communicating with other individuals. Hence the excitation of a sense organ of one individual is conveyed to another one and the latter responds accordingly. This control of one creature by another must have been, from the beginning of its evolution, concerned with advance adaptation.

In the human species we find that the degree of purpose keeps step with the increasing use of language. The naval architect making plans and specifications for a submarine boat, is employing language movements and, at the same time, is behaving with high-degree purpose. In fact high-degree purpose seems almost dependent on language. Let us remember that language movements in man are the result of training, *i. e.*, of the development of habit mechanisms in the nervous system.

For high-degree purpose, a knowledge of the meaning of time is necessary. Until a child has learned the meaning of time, his actions show little definite purpose. He must be taught to note the passage of time. He must learn that it takes a minute to walk to the barn and it takes an hour to walk to the railroad station. He is taught to count the days of the week and the weeks before vacation. Let it be remembered that such knowledge of time is largely due to the development of association or habit mechanisms in the nervous system. By these mechanisms, certain movements come to be associated with the measurement of time.

When the individual has acquired language habits and time measuring habits so to speak, he begins to take part in the joint activities of the family and other social groups. More purposive behavior in the individual is favorable to greater adaptation of the social group to its environment. It follows that natural selection, acting through the group, brings about the evolution of purposive behavior. We can say then that man owes his purposive powers to his social position.

In highly cultured communities, the children are trained up to purposive behavior. This is done by means of language

mechanisms and habit mechanisms. A child is made to tell what he is going to do and what good will come of it. He is trained to plant the seed so as to get the flowers or fruits in due season. As a result the individual not only comes to be highly purposeful but he also comes to think of human behavior as being largely purposeful. Hence he is apt to think that he himself or another man is guided by purpose when he is really guided by habit. He is apt to think also that the purpose that guides his movements is created spontaneously within him, quite independently of his organs of sense or movement.

Let us now go back to more primitive behavior. The animal trainer rewards his dog with a tempting bit of food. Every time the dog performs well, he gets the reward. So the dog associates the reward with the movements that make up the trick. Hence we may say that this behavior is purposive in a sense. He responds to the trainer's signal so as to secure the reward. Now it can be shown that association mechanisms will account for such behavior. Experiments by Pawlow's[1] method prove that after proper experience, a dog's mouth can be made to water at the sight of a green light or other stimulus. Such a response is known as a conditioned reflex. It is plainly a case of association mechanism. The sight of food by a hungry dog has a decidedly animating effect. The effect on his nervous system is evidently widespread. By means of association mechanisms, other kinds of stimulus may be substituted. An animal will run to the feed box when it hears the keeper coming. Any stimulus that frequently occurs a short time before the getting of food will soon establish a sort of conditioned reflex, so that the stimulus will have a marked animating effect on the animal. So when the trainer gives the signal for a trick, it has much the same effect on the trained animal as if food were shown it. The animal is alert and responds readily to the accustomed signals according to the established habit. It then receives a bit of food as its accustomed reward.

[1] J. B. Watson, 'Behavior,' Holt, 1914, p. 65.

Now it may be while the brute is performing that he has something in mind like an image of the food that is to come after the trick, but, whether he has or not, we see that the association nerve paths provide for the proper responses. We see then that although the animal's behavior is in some degree purposive, there is no active power that comes from within, as it were. There is nothing beyond the impulses aroused by the environment and by the trainer's signal. The association nerve paths govern the behavior. The trained animal is then only a piece of machinery, although we must admit that it is in advance of the machinery built by man, for as yet no machine has been constructed by art, even in appearance, that will be influenced by a reward to follow its operations. It is probable that the most intelligent behavior of animals is governed by past experience and present environment and not by what is going to be. So far as animals go then, purpose is, in one sense, only a name, as it were. And yet the dog that goes after a stray sheep and drives it back to the flock seems to have as much purpose as there is in most actions of a human child.

Let us now observe that purposive behavior in animals includes what we may call the faculty of recognition of purpose in others. When you pick up a stone to throw at a dog, he appears to know what you are about to do and slinks off. People used to say that such behavior was due to association of ideas. There is no way to tell when the response is due to association and when it is due to conscious recognition of purpose. When a hunter takes down his gun from the rack, his bird dog shows by her demonstration of joy that she knows her master is preparing to take her out for a hunt in the field. A critical view, however, indicates that it is another case of association mechanisms. Just as the sight of food can cause increase of animation, so can the sight of her master's preparations, by virtue of conditioned reflexes, do the same. The dog wags her tail, leaps and perhaps barks, thus saying in dog language that she is delighted at the prospect.

Let us now review briefly what progress we have made.

We have considered the effect of language habits and time-measuring habits upon purposive behavior. We have found that men are taught to have purpose. We have considered the way reward acts in advance adaptation. In all these items, we have found that associative memory is a most important factor. In view of these relations, we may allow that purposive behavior is underpinned on all sides by association nerve mechanisms. Let us now enquire how the central foundation of such behavior is constituted.

When an animal or child has learned to go through a certain series of movements in a given order, the performance is, as before stated, a memorized series. We have already established that such a series is the operation of nerve mechanisms and that kinesthetic impulses link the movements together. Each one of the movements in turn is provoked by a volley of effective nervous impulses coming by way of converging association fibers, located, we will say, in the cerebral cortex. These fibers have been recently prepared by scout impulses, as it were, that came from the receptors in the muscles that made the movements which went before in the series. Each association fiber received a stimulus or scout impulse from a certain movement which lowered its resistance for a time. It was thus prepared for the effective impulse that came soon after. In this way, we see how each movement in the memorized series is determined by the movements that go before, by means of association fibers which have been developed by previous training. Let us now think of the series so modified that each movement is incipient only, but that it causes afferent impulses that excite other incipient movements in order, so that the incipient movements correspond to the actual movements in the primary series. Let us for convenience call this modified form a secondary series. We see that a secondary series is something like a train of thought.

As above stated, we must presuppose that an incipient movement can in some way provoke an appropriate afferent nerve fiber, so that we shall have an impulse that corresponds to a kinesthetic impulse provoked by an actual movement.

To explain more definitely what takes place, we will recognize two alternative assumptions. The first one is that an impulse is conducted by a motor nerve, although it is too weak to cause contraction of the muscle and is then conducted slowly through the muscle to a sensory terminal of an afferent nerve fiber. Hence a faint discharge from the brain to a muscle is followed by a counter-signal from the muscle to the brain. As an alternative the assumption is that at some nerve junction or synapse there is a short circuit from the motor nerve to an afferent nerve fiber and that the impulse is delayed appreciably at this junction. Hence a faint motor discharge is followed by a counter-signal that reaches the cortical centers and serves in place of a kinesthetic impulse from an actual movement. With either assumption, we see how one incipient movement will provoke another one and there will be a series of impulses running back and forth, from and towards the cerebral cortex. As in the case of the primary series, the counter-signals will follow the common nerve paths where the resistance has been lowered by recent or frequent previous impulses.

We now have a fair understanding of both the memorized series and the secondary series and the relation between them in behavior. Let us therefore attack the main question before us and determine whether such behavior mechanism operations will account for responses that are adapted in advance to changes in the environment.

Let us take a definite memorized series made up of movements which we will call *A B C D E F G H I*, and suppose that it is sometimes replaced by a secondary series, *a b c d e f g h i*. When a child has learned these series, if he is induced to make the movements *A B C*, the other movements *D E F G H I* will be made from habit and if he is induced to make the incipient movements *a b c*, the other incipient movements *d e f g h i* will tend to follow. We may believe that the same association mechanisms are concerned in both series. When the primary series is followed by the secondary series, we may term it a recall. On consideration we see that it may sometimes happen that the secondary series will come in

between the movements of the primary series like this:

A B C D E a b c d e f g h i F G H I.

We see too that here we have something resembling forethought, for the incipient movements *f g h i* show a correspondence with the actual movements *F G H I*, made afterwards. In this way we find that an elementary case of forethought can be accounted for by simple association mechanisms. It is the first step that counts, so it is not an unfair presumption to claim that we could advance by degrees and account for all purposive behavior by association nerve mechanisms. It will be seen that where there is a series of incipient movements that corresponds with a series of actual movements to be made later, a foundation is provided for advance adaptation.

The intelligent animal knows the future by the past. What was the future yesterday morning is now the past. Looking back one sees what he might have looked forward to yesterday morning. From this he may conclude what he may look forward to this morning. Hence the experience of yesterday becomes the forethought of today. The entrance to the path that led to food yesterday will suggest the best path to take today to the hungry animal. If he takes the path and it leads to food again we have a case of advance adaptation. In considering the effect of reward, we saw that such behavior as that is explained by association mechanisms.

Let us now think of a child that makes the incipient movements *f g h i*, as a result of previous operations. Suppose that the afferent impulses from these movements provoke associated language movements as in uttering the words, "I am going upstairs." Then the actual movements *F G H I* of the memorized series are made, such as proceeding upstairs. We see that the uttered words exhibit advance adaptation. Let us note that this demonstrates how a secondary series together with association accounts for purposive behavior. In a similar manner it is thought that behavior equally purposive but not including language

movements can be accounted for. For example, taking a key out of your pocket to unlock a trunk. Of course the necessary common nerve paths must be there.

We may conclude from this demonstration that the secondary series provides a foundation for advance adaptation. It is obvious then that purposive behavior can be explained as due to association nerve mechanisms. On further examination we shall find in very many cases, especially with man, that the secondary series is made up of incipient language movements. A man who is given to talking will hold a silent conversation with himself, before acting in a situation that is not quite familiar. From our point of view, it is all due to nervous impulses that follow the paths most open to them as determined by previous *nerve muscle operations*. We shall also find in human behavior many cases where movements or incipient movements that are associated with measurements of time, constitute the secondary series that anticipates the future situation, so to speak. One can as easily plan for next Christmas as for his next meal. The same kind of nerve mechanisms are employed in either case, and in both the responses are determined by one's past experience. It should be remembered, however, that thanks to the advantages of spoken and written language and to education, a man can make the experience of others serve as his own. That is where the social environment comes in.

The more highly developed the nervous system and the greater the number of association nerve fibers, the more precise and definite will be the anticipation of future needs. An old fox is warier than a young one. An educated man is more purposeful than a savage.

To sum up our conclusions briefly, if habit forming can be explained as due to association nerve mechanisms, advance adaptation can be accounted for in the same way. If our view is the right one, mechanistic interpretations are adequate to account for the purposive character of behavior.

RELEVANT AND IRRELEVANT SPEECH INSTINCTS AND HABITS

BY P. F. SWINDLE

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Introduction

The audible vocal responses of certain birds and of the human being will be the matter of chief concern in this paper; but in order to discuss these responses intelligently, and in order to include all the movements which may be used as means of social communication, it will be necessary to investigate a number of other bodily movements. Excepting the vocal responses, the most important ones for speech are the mouth movements which modify the vocal responses directly. Movements of minor significance are those of the hands, feet, head, eyes, wings, tail, and the like, which may influence in any way the vocal responses, or which may themselves serve as gestures.

All of these responses are instinctive, and all of them may be at the same time habitual; a habit is an instinct which occurs more frequently than originally. The frequency of occurrence of an instinct is necessarily increased if it is associated with, and is regularly conditioned by, at least one other response of the same individual.

Relevant speech instincts and habits are those responses of the individual which serve as stimuli to call forth predictable responses in other individuals. Some speech responses are at the outset relevant, while others are made so through a process of training of the individuals who are to produce, perceive, and respond to them. In other words, many irrelevant speech responses must become conventionalized, if they are not to remain superfluous expressions in ordinary speech.

For the sake of simplicity in dealing with vocal responses,

I shall make use of the vowel names, *a*, *e*, *i*, *o*, and *u*, as abbreviated means of speaking of the very large number of vowel sounds which an organism in question may utter. The qualitative nature of any given vocal sound could be indicated by marking diacritically one of these five letters, but it would be unnecessary and perhaps confusing if the attempt should be made in the following pages. It will be necessary, however, to indicate in a limited number of cases the specific qualitative nature, *e. g.*, of an *a*; but in general the reader will be privileged to image or utter any *a* sound which occurs to him at the time.

In discussing the consonants, I shall also speak primarily of some of the simpler consonant names of the alphabet as the most familiar representatives of the very large number of consonant sounds which the organisms utter.

Experiment and Discussion

To understand conventional speech, it is advisable to study carefully some simple forms of speaking organisms. I shall for this purpose begin with the *barbet*, or, as it is usually called, the 'bearded bird.' It frequently speaks, or more strictly sings the letter *a* somewhat as in *art*. When the bird is not molested it utters a succession of *a*'s approximately in the tempo of 0.2 sec. These sounds form a great number of *a*-groups, the largest one of which contains not less than five hundred *a*'s as its elements. When the group is very long an observer can become aware of a progressive, qualitative change of the *a*'s. The change is usually so gradual that it is not apparent in the shorter groups. Often the mouth closes at the end of a group in such a way that the final *a* is converted into a sound resembling the English *r*. When an *a*-group is thus terminated, I shall speak of an *ar-group-compound*, or simply of an *ar*-compound. The *a-group-complex*, or the *a*-complex, which is the summation of the quantitatively identical and different *a*-groups, is the most essential one which the vocal apparatus of this bird manifests.

The mouth movement which occurs regularly at the end

of a given *a*-group and converts the final *a* into an *r* sound, is a specific activity which at some previous time interrupted a series of *a*'s and became permanently associated with the final *a* of the *a*-group which it isolated from the longer series. This mouth movement became the permanent conclusion or final accent of the isolated *a*-group. The following experiment makes this view plausible.

Observing the bird carefully, I struck, whenever possible, the glass of its cage at the fourteenth *a*. This stimulus called forth the mouth movement which interrupted the series of *a*'s and served to convert the fourteenth *a* into an *r*. It became eventually so well associated with the final element of the 14-*a*-group that I no longer had to apply any stimulus to the bird at this point of the series. The *ar*-compound which thus came to be uttered as regularly as the 14-*a*-group occurred, consisted in all of fifteen perceptible elements: first, thirteen *stutters*, that is, the *a*'s which were unnecessary for the perfect pronunciation of the *r*; secondly, the significant *a*, the only one necessary for the *r*; and, thirdly, the mouth movement which made the audible difference between the fourteenth *a* and the preceding ones. The bird was also taught by the same method to utter an *ar*-compound consisting of thirty-three stutters and the *r* which was a modified *a*. No other habits were acquired by this animal under experimental conditions.

The particular training to which the bird was subjected habitualized the mouth movement; that is, it caused this movement to occur more frequently than originally.[1] After the training, the mouth closed not only when the glass of the bird's cage was struck, but also whenever the final *a* of either the 14- or the 34-*a*-group occurred. No portion of an *a*-series was caused to occur more frequently than originally, and consequently not even the 14- and 34-*a*-groups can be called habits. This training, at least, did not make them habits.

[1] For a more detailed discussion of instinct and habit, see my article, 'Ueber einfache Bewegungsinstinkte und deren künstliche Beeinflussung,' *Z. f. Sinnesphysiol.*, Bd. 49, 1915. See especially pp. 247–248 for my definitions of instinct and habit.

The training did, however, cause certain *a*'s to occur less frequently than originally. For example, in the case of the series from which the 14-*a*-group became isolated, the fourteenth *a* conditioned the mouth movement instead of the fifteenth *a*; and with the mouth closed the bird could not continue the series. This does not mean that the latter part of the original series vanished completely, but only that the fourteenth and fifteenth *a*'s became dissociated. The most significant result of this complete dissociation was the addition of one more group to the *a*-group-complex.

The *cockatoo* is a bird whose speech instincts outnumber those of the barbet. Its vocal apparatus functions in various tempi, as is indicated by the differences in pitch of the many tones; and the mouth moves in various tempi, directions, and amplitudes. A large number of group-complexes is manifested by the vocal apparatus and mouth parts. The cockatoo, like the barbet, stutters; but the succession of the elements of an audible series is usually so rapid that only a continuous tone is perceived. It is sometimes a whistling tone. The mode of whistling is, however, quite different from that of the human being; for, while the human being whistles mainly with his lips, the cockatoo, which is almost void of soft lips, produces these tones primarily with its vocal cords.

When any one of the vocal responses of the cockatoo is interrupted by a mouth movement a compound almost invariably results which might well be used in conventional speech. Many mouth movements are of such slight amplitudes that a vocal series which is in progress at the time may not be interrupted completely, but only slightly modified by them at the points of the series where they occur. Further, these movements are often of considerable duration. I learned that I could call forth a large number of these movements in a desired order, and took advantage of the situation to teach a *yellow crested cockatoo* to whistle recognizably a certain simple portion of 'The Wearing of the Green.' The cockatoo had never heard this melody until it itself produced it. The stimulus I used to modify the monotones

which the bird for some unknown reason frequently whistled, was a burning candle which I moved in various directions and with various speeds before the animal. In whatever direction the candle was moved, the cockatoo threw its head or even its entire body toward the flame. For example, when the candle was moved to the left, the bird often raised only the left foot and thrust its body in that direction. Many of these thrust-like movements were accompanied by alterations in the size of the mouth cavity. Thus the tone could be modified successively in various ways.[1] The method used to cause the cockatoo's tones to become melodious, also caused it to dance to the movements of the flame. At other times, *i. e.*, in the absence of the candle, it danced as if to the tune it produced. At these odd times the thrusts of the head or entire body were not quite so pronounced and sudden as when I called them forth with the flame, and the dancing was accordingly more graceful and the whistling more melodious.

I also used various other stimuli which called forth the desired responses when properly moved before the bird, but the candle was the most useful one I found. Some of the others were a piece of ermine fur, a bundle of feathers, a frog, and a dead mouse. The burning candle was especially adapted for this investigation, not merely because the flame was a stimulus which the bird's eyes generally followed, but because its shape and size could be varied with the velocity of movement. When moved rapidly, the flame became very small and then flared when the movement ceased. I could make the flare of the flame so disturbing to the bird that the tone would be interrupted completely, which event I avoided in this particular experiment.

There are some very brief mouth movements manifested by the cockatoo which do not interrupt a vocal series com-

[1] This particular bird was the most suitable subject I found for this experiment. Other cockatoos responded to the flame in a similar way, but their movements toward it were not so pronounced, and the tones were not altered in the same degree. I also worked in the same way with a small owl, whose vocal utterances were more similar to those of the barbet, and determined that its vocal responses became slightly modified at many turns of the head.

pletely, but only alter the tempo slightly and become inserted between two of the elements. Such a compound would be *aaapaaaa*, or *eeetee*.[1] Any such mouth movement which can be caused to occur once in a vocal series, may be caused to occur twice, and if the bird in a given environment is stimulated to insert a *p* in an *a*-series, it will very probably be stimulated in the same way soon again. This is a form of natural training which is evidently responsible for many of the compounds spoken by wild cockatoos. Some of the more frequent of these are: *aaapaapaa*, *aaaamaaamaa*, *aakaaakaaa*, *uutuuutu*, *eeemeemeee*.[2] These activities are not necessarily rhythmical, because the mouth movements in any case do not necessarily occur at absolutely regular intervals.[3]

It is not necessarily the case that a vocal response becomes thus slightly modified two or more times by the same mouth movement. The mouth is capable of executing a great variety of movements, and it is scarcely conceivable that the stimulus for only one of these should be present in any given environment. Further, if the bird should take a step or perhaps turn the head after the mouth has moved the first time, and while the vocal response is still in progress, such an act might create a sufficiently new environment for the animal that it would now be exposed to a stimulus for a decidedly different mouth movement. Some of the resulting compounds might be: *aaaapaaataaaaa*, *aaaaaapaaateeeeeee*,

[1] Any series of like letters not separated by commas are meant to indicate elements of a vocal response which is only apparently continuous.

[2] Perhaps Binet and Simon had such compounds in mind while investigating the child's language. Alfred Binet et Th. Simon, 'Langage et Pensée,' *L'année Psychologique*, 1908, p. 310: "Comment pourrait-il prononcer des mots qu'il n'a jamais entendu, et si on ne les lui a pas appris par une autre voie? Il existe donc, au moment de l'élaboration des fonctions, des relations nombreuses entre les fonctions naissants."

[3] Wundt calls special attention to the fact of the repetitions in the child's utterances, but he seems to think the phenomenon is due to its appreciation of rhythm. Wilhelm Wundt, 'Die Sprache und das Denken,' *Essays*, Leipzig, 1906, 2. Aufl., S. 281: "Eine primitivste Äusserung des Gefallens am Rhythmus ist wohl auch die Neigung zur Wiederholung der Laute, durch die beinahe alle Wörter der Kindersprache zu Verdoppelungsformen geworden sind. Ursprünglich sind aber die Wiederholungen fast immer mehrfache, und erst allmählich sind diese zu den geläufigen Verdoppelungen, Papa, Mama, Wau-wau, u. dergl., verkürzt worden."

eeeteeeepaaa, aaaaakaaakaaaatuuuu, and the like. In the last instance, *e. g.*, the *u*'s follow the *t* because the initial *u* of the *u*-group became at some previous time associated in this order with the mouth movement responsible for the *t;* and if the bird does utter the *u*'s, it cannot utter the *a*'s at the same time. The *tu*-compound, or whatever is responsible for it, which in this case inhibited a number of *a*'s, served the same purpose as the mouth movement of the barbet: the barbet was unable to pronounce the *a*'s while the mouth was closed, and the cockatoo was unable to pronounce the *a*'s while uttering the *u*'s.

One reason why so many of these words more often start with a consonant than with a vowel, is that the very movement which opens a closed mouth to utter a vowel group is quite frequently one which is indispensable for many of the consonants. If the bird should be stimulated to utter the series *uuuu* at a time when the mouth is not already in the proper position for this act, it might be opened suddenly and thus permit the cockatoo to say *tuuuu*, *puuuu*, or some other consonant. We should look upon the last three of the *u*'s in either of these cases as stutters, because they are not necessary for the perfect pronunciation of the *t* or *p*. The letter *t*, as it appears on paper, is only a symbol for some one of the many forms of a vowel which is modified by a mouth movement. We can write the letter *t* without the vowel of which it is a modification, but while this exists as a visual stimulus, it is an impossibility in audible speech. The written *t* of the alphabet signifies the *te*-compound. Another reason for the fact that vocal responses so frequently start with a consonant is that the brief mouth movements essential for the pronunciation of many of the consonants occur much more frequently than the vocal responses; no animal speaks every time it opens its mouth. This means that the proper mouth movement for a given consonant often occurs and modifies a vowel sound, provided that upon the opening of the mouth there occurs a vocal response to be thus modified.

Many speech compounds, however, *must* start with a vocal response. For instance, any one of the consonants of our

alphabet, which is not one or another of the vowel forms initiated by and modified by at least one mouth movement, is initiated by some vocal response, the last element of which is modified by the mouth movement. This means that some of our consonants would be impossible in verbal speech if certain vocal responses could not be in progress when the significant mouth movements occur. These consonants of the alphabet are the *ef-*, *ah-*, *el-*, *em-*, *en-*, *ar-*, *es-*, and *ex-* compounds. The existence of such compounds as these and many other similar ones which do not appear in the alphabet, illustrate clearly the impossibility of starting a rather large number of our conventional speech compounds with mouth movements, for, in these cases, the mouth merely moves and modifies vocal responses already in progress.

The vocal and mouth movements of the cockatoo can be associated under controlled conditions to produce not only the various consonant names, but also great numbers of our monosyllables, and these can in turn be associated with one another to form larger compounds such as our polysyllabic words. A monosyllable is for the speaking organism just as simple as, or at least not much more complex than, most of our consonant names. A monosyllable in speech is merely a more or less compound utterance that maintains its identity when associated with other speech compounds, more often than do our consonants, which are also compounds. In other words, a monosyllable is ordinarily not as variable as a consonant name, and is usually just as easily spoken. The consonant names consist of *a-*, *e-*, *i-*, *o-*, or *u*-groups which are either preceded or succeeded by a mouth movement that modifies at least one element of the group. This mouth movement is of such magnitude and brevity that the resulting audible effect is usually an explosive one. The monosyllables consist of like vowel groups, which *may*, however, be preceded and also succeeded by the distinct mouth movements.

The vowels, too, are groups which are often modified by mouth movements; the mouth frequently moves before as

well as after each vowel group, but these movements do not produce such explosive effects as in the cases of the consonants and monosyllables. Various tendencies which manifest themselves when we attempt to pronounce the vowels, deserve emphasis. In uttering *a* or *i*, the *a*-group or *i*-group is frequently terminated in each case by an *e*-group, while the *u*-group, on the other hand, instead of being terminated by an *e*-group, is frequently preceded by it. In the face of these facts we are not justified in writing for the vowels only the *a*-, *e*-, *i*-, *o*-, and *u*-groups, but we must add the *ae*-, *ie*-, and *eu*-compounds, as well as others. These compounds represent only three of the so-called diphthongs of speech; and even they, depending in general on whether they occur at the beginning, in the middle, or at the end of our larger speech compounds called words, are under conditions differently pronounced.

While the majority of the mouth movements are such as can modify vocal responses, it is to be borne in mind that there are a great number of other bodily activities which neither completely interrupt nor modify in any observable way the audible vocal responses. Some of these are the movements of the tail, wings, hands, feet, head, and eyes. True enough, these may carry the body through space and cause the speaking organism to become affected by a number of different stimuli which call forth various mouth movements. An eye movement may sometimes appear to alter a vocal response which is in progress when the eye moves, but a safer supposition is that it conditions a mouth movement which interrupts the vocal response or modifies it in one of the other ways previously discussed. Any movement of the body can become associated either directly or indirectly with a vocal response and condition it, be conditioned by it, or merely accompany it; but the mouth movements alone can interrupt it.[1] Many of the larger movements of the body which are associated with vocal responses, and which appeal primarily to the visual sense, are called gestures; but

[1] For reasons that should be obvious, I am considering only those vocal responses which occur during the period of exhalation.

there is really no fundamental distinction to be made between these and the movements of the vocal cords, or of the very slight movements of the various parts of the mouth. Any given perceptible response of an animal organism becomes a means of social communication when it stimulates other beings to behave in a predictable way. Some of these movements may be perceived with the ear, some with the eye, and some with both eye and ear. It is a matter of insignificance what sense organ they affect. Those perceptible movements which do not call forth predictable responses in other individuals, since they have not become conventionalized, are nonsense expressions. The process of conventionalizing responses for means of communication is nothing more nor less than a process of training the individuals who are to utilize them to stimulate one another for calling forth predictable responses.[1]

The human being often stutters in a manner similar to the barbet, but, as does the cockatoo, in such a very rapid tempo that for the hearing organism an apparently continuous tone results. He stutters thus either before the interrupting mouth movement occurs or after it. The tendency of the human being to stutter in this way is indeed very great, as is illustrated by the manner in which the infant 'coos' and by the way it later utters such words as *maaaaaaaaaa*, or *paaaapaaaaaaaaa*. In the earliest stages of infancy the child does not often begin these words with *m* or *p*, but, as the cockatoo often does, with *a*. They should accordingly be written somewhat as follows: *aaaaaaaaaaaaaaaa*, *aaaaaaapaaaaapaaaaaaaaa*. The mouth movement of the child which is responsible for the *m* sound within an *a*-series

[1] While this point seems obvious, it has not been given due attention by the investigators of speech. Wundt, for example, in his 'Physiologische Psychologie,' III., S. 285, says: "Alle Ausdrucksbewegungen geschehen selbst beim Menschen im Anfang des Lebens unwillkürlich; sie sind teils Triebhandlungen, teils reflectorische Bewegungen. Allmählich erst werden einzelne willkürlich gehemmt, andere hervorgebracht, und es entstehen auf diese Weise willkürliche Ausdrucksformen;" and also, S. 452: "Auch die *Sprache* ist in gewissem Sinn eine form der Geberde. Sie entwickelt sich wahrscheinlich teils als affectartige, teils als nachahmende Bewegung."

merely occurs simultaneously with one or more *a*'s and does not even alter the tempo of the series as does that movement responsible for the *p*. When the *m* is uttered the *a*-series continues as a nasal sound, which does not occur with the cockatoo.

Other prevalent compounds spoken by the child are: *aaaapaaakeeeee*, *aaaaaaaameeeee*, *aaapaapeeee*, *aadaaadeeee*, *aaaabaabeee*, *aaaaapaaapuuus*, and the like. And in reading, the child says "Whaat iiis thiis? Iiit iiis aaaaa hooorse aaaand aaaaa cooolt. Caaaan youuu riiide theeee cooolt? Oooh, no! Iiit iiis toooo liittle." Stimulate the child by telling it to read more rapidly, and it will very often pronounce the words so indistinctly that they can be understood only with difficulty. One child which was thus stimulated seemed to read the words as follows: "Wat is sis? It is a hog and a shoat. Can you wide de shoat? Oh, no! It is too witte."

There is moreover a second variety of stuttering which is quite closely related to stammering. An adult once asked: "I, i, i, i, is ti, ti, ti, this the ti, ti, train for A, A, A, A, A, A, A, Aurora?"[1] If one tries to stutter in this manner in pronouncing *Aurora*, one easily observes that these are not the same, but qualitatively and quantitatively different *A*'s which succeed one another; each of these is in reality an *A*-group, seven of which are nonsense or superfluous expressions. The eight different *A*'s may be indicated as follows: *AA*, *AAAAA*, *A*, *AA*, *AAAA*, *AAAAAA*, *A*, *AA*Aurora, or, as follows: 2-*A*-, 5-*A*-, 1-*A*-, 2-*A*-, 4-*A*-, 6-*A*-, 1-*A*-, 3-*A*-group. Although each group has its accent which is either a mouth movement or a movement of the respiratory muscles, the final accent of the 3-*A*-group is most easily observed. The speech compound represented by the letters *ro* was not associated with the 2-, 5-, 1-, 4-, or 6-, but with the final element of the 3-*A*-group, and other *A*-groups merely preceded this one. The expectation arising from this view that the individual would occasionally not

[1] As the word *Aurora* was spoken the *u* was silent, and the initial *A* was pronounced in the same way as the *a* of the alphabet.

stutter in the indicated fashion in speaking *Aurora*, is realized: he does not stutter thus when the 3-*A*-group is the first one of the possible *A*-groups to occur.

The same fundamental statements can be made concerning the *ti*'s that were uttered before the word *this* was pronounced. In this case the mouth movements which resulted in modifying the initial element of each of the *i*-groups was more pronounced than any of those which accompanied the *A*-groups. When the compounds are as distinct and as explosive as these *ti*'s, I shall call them stammers. There is not the *ti*-compound in the word *this*, and the stammerer who has an image of the word simply has to wait until he is properly stimulated to utter the compound which begins with the very peculiar mouth movement responsible for the *th* sound. He would have no trouble in speaking the word if he would in the attempt either sneeze or imitate a sneeze. All of the various compounds which appear as stammers, involve at least one vocal response and at least one distinct mouth movement. The failure to recognize the fact that even the simplest stammers involve in each case at least one form of a vowel group which is modified by a mouth movement, has led investigators of speech to very serious errors.[1]

Many stammers are conventionalized compounds which either merely occur at inappropriate times, or which are unnecessarily repeated. They are accordingly not only

[1] The following quotation taken from C. S. Bluemel's 'Stammering and Cognate Speech Defects,' I., p. 187, is one of many cases which I could choose to illustrate this point. "*The stammerer's difficulty is transient auditory amnesia:* he is unable to recall the sound image of the vowel that he wishes to enunciate. This then is the thesis of the present monograph. . . . His futile struggles with the initial consonant are directed solely by his kinæsthetic imagery, but he cannot pass to the vowel because he cannot recall its sound, its peculiar or characteristic quality—in short, the *vowel-color*. When he attempts to speak the word *ten*, he produces the *t* entirely by feeling; but he cannot mentally hear the sound *ĕ*, and is hence unable to proceed." My criticism of the thesis of the monograph is that the stammerer utters the vowel whether or not he recalls its sound; for, in his attempt to pronounce the word *ten*, his stutters are generally a number of *tĕ*-compounds. The *t* which the author has written, is only a visual stimulus symbolizing the vowel which is modified by a mouth movement. The compound *tĕ* can be spoken, as the stutterer does, but we cannot utter a *t* apart from the *e*, *ĕ*, or some other vocal sound.

often superfluous, but even harmful in speech, in so far as they distort the compounds which the stammerer is attempting to use to call forth predictable responses in other individuals. Take, for example, the compound 'you know.' When one says, "Do you know the name of that mountain?" or, "You know what I mean," there is no violation of a conventionality of speech; but, when one says, "Did you ever, *you know*, smoke a cigar in the wind?" the superfluous 'you know' is a non-conventionalized or stammering expression. Other common superfluous utterances are 'Well,' 'Oh,' 'Now look,' 'Now listen,' 'Now,' 'Don't you think?' 'Don't you know?' 'Isn't it?' 'Yes sir!' and so forth. We often hear such meaningless expressions before or after a sentence, or indeed often after mere phrases of it.

The simple fact that a speech compound is at one time a nonsense and at another time a sense expression, means that our training methods are not adequate to enable us to use all the speech manifestations of the organism in all the combinations they so frequently help form. It is important that any nonsense expression can become conventionalized by training the individuals of the social group to respond in a definite way when stimulated by the expression. Our conventional speech is accordingly reduced to a form of stuttering and stammering, the stammers being the more pronounced elements. Some stutters and stammers are common to a greater number of individuals than are others and are consequently more highly conventionalized. Generally, only the more idiosyncratic utterances are superfluous in ordinary speech.

A *bald-eyed cockatoo* was taught to stutter. It was taught to repeat after me the word 'Kakadu,' the German for cockatoo; but it did not say 'Kakadu' immediately: first it said 'What,' 'Jako,' 'Kak,' 'Kak,' and then 'Kakadu.' While the bird frequently uttered various compounds before saying 'Kakadu,' the training to which I subjected it established this particular order. It was also trained to stammer in certain very definite, but silent ways after the word 'Kakadu' was spoken. My primary interest was in the

speaking of the word 'Kakadu,' and I accordingly called all those compounds which were uttered or produced in any other way before and after this word, stammers. For a second observer the word 'Kakadu' might have been only one of the stammers which regularly occurred after the word 'Jako.' A wild cockatoo may utter a series of compounds which become established through self-training; but any one of these may be of the same interest to us as any other one. If we should become able, by training ourselves for the purpose, to respond in a definite way, or, in other words, to attribute a definite meaning to the whole of such a series of compounds, we should be inclined to consider no element of it a stammer. Also, if the cockatoo should be taught a conventional sentence with a subject, a predicate, and so forth, tradition would scarcely permit us to speak of stammering activities, in spite of the fact that the cockatoo may not have been taught to use the sentence in the conventional way.

It is a noteworthy fact that well-established, conventionalized sentences of the human being become frequently distorted with stutters and stammers. It is peculiar, but interesting, that students of ancient languages, who use their knowledge of these to speak a more correct English, do not as a rule speak fluently; they often pause in the middle of a sentence and insert a few stammering expressions before going further. These stammers are activities which interrupt the established series of conventionalized compounds and become associated with some of their elements just as the mouth activity of the barbet interrupted a long series of innately associated *a*'s and became associated with the fourteenth or final *a* of the 14-*a*-group. Those Greek and Latin scholars who, according to their introspections, do not attempt to use their knowledge of these languages while speaking their mother tongue, may speak as fluently as other people. The fact that our Greek and Latin scholars may and usually do speak, provided we neglect their non-conventionalized stammers, a more grammatical English, and also that they may possess an extraordinarily large and varied vocabulary, has nothing to do with our present problem. A student

of logic may make fewer fallacies in his reasoning; that is, his responses may conform more with convention, by having studied logic; but a logician who attempts to apply his principles of logic and to speak fluently at the same time will acquire habits of stammering. Stimuli which may cause a person to stammer thus, may have many sources.

A non-excited person may say *Aurora*, but when in a state of excitement he may say *A*, *A*, *A*, *A*, *A*, *A*, *A*, *Aurora*. These *A*'s represent eight qualitatively different *A*-groups which became isolated from different parts of an *A*-series which can be represented as follows with the potentially adequate stimulus for each *A* underneath it: *A A A A A A*
$a^1\ a^2\ a^3\ a^4\ a^5\ a^6$
A A A A A A A A A A A A A A A A A A A A A A A A.
$a^7\ a^8\ a^9\ a^{10}\ a^{11}\ a^{12}\ a^{13}\ a^{14}\ a^{15}\ a^{16}\ a^{17}\ a^{18}\ a^{19}\ a^{20}\ a^{21}\ a^{22}\ a^{23}\ a^{24}$
When the stimulus a^1 is presented the first *A* is conditioned by it, the second *A* is conditioned by the first, the third by the second, and so on. If a^1 should be removed as soon as the first *A* is conditioned, the after-response would consist of the remaining twenty-three *A*'s. If a^5 were the stimulus presented, the fifth *A* would be conditioned by it, and the after-response would consist of the last nineteen *A*'s. There are experimental and also theoretical reasons for asserting that a^5 can be presented repeatedly without bringing about a dissociation of the fourth and fifth *A*'s, but in this discussion we do not need to consider why it should be the case. If the 24-*A*-series appears more frequently than any of its parts, this means either that a^1 is a stimulus which affects the organism more frequently than does any one of the other stimuli, or that the first *A* is conditioned not only by a^1, but also by one or more frequently occurring responses which have become associated with and precede the first *A*. It may well be the case that of the potentially adequate stimuli here represented for the different *A*'s, a^1 is the only one present in a given environment. If then, while the series is in progress, a mouth movement should occur and isolate the first three *A*'s from the remainder of the series, the 3-*A*-group only will occur as long as the person remains in the given environment.

If the individual should shift to a new environment and become affected by a^4, the 21-*A*-series will occur and become habitualized, because the initial *A* of this series will become associated with and later be conditioned by the response which happened to occur immediately before it. This accidental response will now serve as a substitute for the 3-*A*-group which became previously isolated from the original series. We could proceed in the same way until we get the series broken up into a number of fragments or unitary groups each of which maintains its identity in many different environments by occurring more frequently as a whole than in parts. These unitary fragments of the original series may be the 3-*A*-, 5-*A*-, 1-*A*-, 2-*A*-, 4-*A*-, 6-*A*-, 2-*A*-, and 1-*A*-groups. If it should be such a compound activity as *rora* (I omit the *u* because it is silent in the spoken word Aurora), which isolated the 3-*A*-group from the original series and became associated with the final element of this group, the individual would be able to pronounce the word Aurora only when the 3-*A*-group occurs. If it should happen that while he has an image of the word he should be stimulated to produce the 5-*A*-group, which is not associated with the 3-*A*-group, at least one more effort would have to be made before the word could be pronounced.

Let us suppose that the individual happens to be in an environment in which the stimulus for only the 3-*A*-group is present. He would succeed at the first effort to pronounce the word. If he should pass to a new environment which contains the stimuli for all the groups, he might by chance have to make many efforts. Now it does not matter whether he actually passes into a new environment or whether these stimuli are introduced into the old one, leaving it otherwise unchanged. It would be the same if they should be secreted by his own body. Perhaps they are under certain conditions secreted by some of the ductless glands of his body. Perhaps some of the hormones secreted under conditions of excitement are adequate stimuli to condition a number of the superfluous *A*-groups while he has an image of the word Aurora. It is thinkable that the hormone secretion could be of such a

nature that if it should not call forth all the *A*-groups simultaneously, it might cause them to occur in very rapid succession. In the first case a 'boisterous' *A* sound of relatively short duration would result, and, if the final accents of the superfluous *A*-groups should be relatively insignificant for the hearing organism, it might seem in the second case as if one long *A* were being uttered before the word Aurora is pronounced. A hormone which is, under certain conditions of stimulation, thrown into the blood, may be analogous to a response which a training in logic, Greek, or Latin has caused to occur quite frequently and necessarily interrupt at times either an instinctive vocal series or an habitualized series of speech compounds.

Out of the previous discussions arises the practical problem as to the surest and most economical means of breaking an individual of stuttering or stammering. In order to solve this problem we should become thoroughly acquainted with the process of teaching a subject to stammer. I noticed that when I stepped noiselessly to the bald-eyed cockatoo's room and, before opening the door, said 'Kakadu,' the bird said 'What,' and when I said 'What,' the bird said 'Kakadu.' When I rattled the door knob or opened the door without showing myself, the cockatoo said 'Jako,' when I jerked its cage with a string it said 'Kak,' and when I suddenly appeared in the room before the bird, it said 'Kakadu,' after which it began beating a horizontal bar of the cage with its beak, becoming then active in a number of other ways. In the course of time I found many stimuli which called forth the mentioned responses; but I made use only of the particular ones here given. Before the bird was aware of my presence outside its door I called out 'Kakadu!,' opened the door without showing myself, jerked the cage twice in succession, and then entered the room suddenly. After each stimulus the bird made a verbal response, the entire series of which was 'What, Jako, Kak, Kak, Kakadu,' after which it beat the horizontal bar with its beak. It was necessary for me to carry out this program several times each day for about three weeks before the bird pronounced the series

regularly without error when I spoke the word 'Kakadu.' I discovered that after the series was well established I no longer had to go through with the ordeal of stimulating the bird by calling out the word 'Kakadu' while still outside the door; I could remain in the bird's room for some time and then utter the word 'Kakadu,' and the series would be spoken just as perfectly as when I called through the door.

At the end of two months I employed the following means to break up completely this series of associated speech compounds. I said 'Kakadu' repeatedly and as rapidly as I could for several minutes during each period, and after about three days this stimulus no longer served to instigate the series. However, when I rattled the door knob, the cockatoo omitted 'What' and began the series with 'Jako.' I then presented this stimulus repeatedly without long pauses until it likewise became ineffective. As soon as this task was accomplished, I repeatedly jerked the cage with the string until this stimulus was no longer effective. Of the three tasks, the last one was the most difficult to accomplish. When the series was thus completely broken up and I spoke the word 'Kakadu,' the bird generally said something, but not always 'What,' as it did before the training, and it said 'Kakadu' no more frequently than it did 'Jako,' 'Kak,' 'Ohoh,' 'Adieu,' or almost any of the many other sense or nonsense words which it could utter. Now, when it said anything other than 'Kakadu,' I repeated the stimulus for some time, and as soon as the bird said 'Kakadu,' I made a long pause before restimulating it in the same way. This procedure was necessary in order to make the cockatoo act as if it were imitating me. Before I could bring about this apparent imitation it was necessary for me to cause the rather complex stimulus used to become ineffective for a considerable number of stammers. I have applied this method of dissociation with equal success in various other fields of behavior.

If we now desire to apply the method to the human stutterer or stammerer, we should proceed somewhat as follows. Paradoxical as it may sound, we should present in

rapid succession the adequate stimuli for the undesired activities. If we cannot find or cannot control the most adequate ones for these responses, we should use those less adequate ones which we do have at our command. For example, when a person, attempting to speak a word, stutters or stammers, we should simply stimulate him by telling him to do that same thing again and again, perhaps a hundred or a thousand times in rapid succession. But care must be taken that he does the *same* thing and not something which may be only very similar to the particular undesired act. After he has repeated the act a great number of times, he should then be stimulated to pronounce the word which was previously preceded by the undesired activity. It is essential that he should make a pause of at least a minute each time before he repeats the word; otherwise, this word, too, will appear less frequently and will not always be recalled at the significant places for it in ordinary speech. This process of dissociation will not effect an absolute forgetting of the undesired responses, but will cause them to occur less frequently at the inappropriate places.

It is to be emphasized that this dissociation does not mean an absolute forgetting of any activity. In the case of the cockatoo, for instance, each of the relatively forgotten or dissociated elements of the series of speech compounds, was later spoken at times just as perfectly as previously. Excepting the word 'Kakadu,' each of the compounds occurred less frequently than before the dissociations were accomplished. This relative forgetting brought about by continued stimulation is sometimes spoken of as 'forgetting with experience.'[1] We have no reason for supposing that any of the organic structures involved in the so-called forgotten responses became annihilated. Owing to the fact that the recuperation pauses were made as short as possible, certain structures involved became at least temporarily simplified to such an extent that they later functioned only upon the presentation of very particular, and, naturally, a smaller number of stimuli; the structures became 'immuned'

[1] See for example, H. Piéron, 'L'oubli chez la Limnée,' *Archives de Psychologie*, No. 33, Tome IX., 1909.

to certain stimuli. The simple fact that a person can stutter and stammer when properly stimulated to do so is significant in this connection. The fact that an expert rope walker returns to an amateur level of performance the very moment he, as we ordinarily say, 'gives serious thought to what he is doing,' is a phenomenon of the same category. The simplification of certain of the organic structures involved in a given, desired response to bring about its dissociation from other undesired responses, is, I believe, the fundamental principle underlying the facts of dissociation or relative forgetting, the automaticity of certain responses, and a few other related phenomena; but it would not be appropriate to attempt the explanation in this paper. I have merely inserted this view as a suggestion that my method of breaking up such undesired activities as those of stuttering or stammering can be explained without assuming the annihilation or permanent exhaustion of any of the structures involved.

Conclusion

Speech instincts and habits are the perceptible responses manifested by an individual which serve primarily as auditory and visual stimuli to call forth responses in other individuals. These stimuli are vocal utterances, mouth movements which modify audibly the vocal responses, and the larger bodily movements which affect primarily the visual sense.

A vocal instinct is a series of innately associated elements which presents a gradual, qualitative change from the initial to the final element. Any vocal instinct may be called a vowel series. There exist besides the *a*-, *e*-, *i*-, *o*-, and *u*-series, a number of vocal instincts which may be indicated by appropriate diacritical markings of the vowels of the alphabet. But a marking which designates the sound of the first few elements of a series is often quite inappropriate for the last few elements of the same series. For this reason, diacritical markings should also be employed to symbolize, *e. g.*, the different *a* sounds which can frequently be detected between the initial and final elements of a given *a*-series. Theoretically, if the anatomy were such that an *a*-series

would not be prematurely interrupted by exhalations, there should occur within this series all the *a* sounds which the organism can utter. The gradual, qualitative changes of the *a*'s within the longest *a*-series of the barbet support this supposition.

A vocal response is a habit, as well as an instinct, when it is caused to occur more frequently than originally. The process of habitualizing a vocal response is a process of training which causes the instinct to become the final accent or conclusion of one or more responses which originally did not regularly precede and did not condition the initial element of the vocal instinct. The whole or any fragment of an instinct is not necessarily a habit, but a habit is invariably an instinct.

Vocal responses are essential for audible speech and are accordingly speech instincts and habits.

Mouth movements serve to interrupt vocal instincts and habits and isolate fragments or unitary groups of elements from them. A given mouth movement which isolates a unitary group from a longer series of *a*'s becomes at the same time associated with the final *a* of the isolated group and is later conditioned by it. This instinctive mouth movement which becomes the final accent or conclusion of the isolated *a*-group, is thus caused to occur more frequently than originally and is accordingly a habit as well as an instinct.

There are many mouth movements of such slight amplitude and of such brief duration that they may not completely interrupt a vocal response, but merely modify it slightly. Such mouth movements may only modify slightly the tempo of certain elements of a vocal series and become inserted between two of them, as in *aaaaaaapaaaaa*, or they may occur simultaneously with one or more of the elements, as in

m
aaaaaaaaaaaaaaa.

Mouth movements are as essential for audible speech compounds as are the vocal responses and should likewise be reckoned among the speech instincts and habits.

Larger movements of the hands, feet, head, and body in general, serve to carry the organism through space and cause

it to become affected by a variety of stimuli which may not occur in any given environment. Many of these stimuli call forth mouth movements and vocal responses which become the final accents or conclusions of the movements of transportation and are later conditioned by them. Further, the less perceptible movements of the eyes serve the same purpose.

All of the bodily movements which cause mouth movements and vocal responses to occur more frequently, should also be called speech instincts and habits.

Any instinctive or habitual response of an organism is a means of social communication if it is used to stimulate individuals of known training to behave in a way which can be predicted from the nature of the stimulus. In discussing speech instincts and habits, it was necessary to discuss some problems of stuttering and stammering, because our conventional speech is only a form of behavior of which stutters, stammers, and larger bodily movements are the elements. When these elements of speech are conventionalized, they are ordinarily called letters, monosyllables, words, sentences, and gestures. A series of innately associated stutters which is modified by one or more mouth movements to produce such a speech compound as a consonant or a monosyllable, is a stammer. A number of like or unlike stammers may be combined through association to form larger speech compounds, such as polysyllabic words and series of words; but these are merely stammers of a higher order. The process of conventionalizing a stutter, a stammer, a number of associated stammers, or any other simple or compound response, is a process of training the individuals who are to utilize these to call forth predictable responses in one another.

Any artificially combined series of speech compounds can be interrupted in the same way as can an innately associated series of simple elements; and a response which either completely interrupts a conventional series or merely becomes inserted between two of its compound elements, is analogous to a mouth movement which either completely interrupts or merely changes slightly the tempo of movement of a vocal

instinct. Those responses which occur most frequently are most likely to interrupt the conventional series. A training in ancient languages or in logic may cause them to occur frequently. A hormone secretion may affect the speaking organism in a similar way.

It seemed appropriate to present a method to diminish the frequency of superfluous utterances, which are undesired stutters and stammers. This method consists in presenting appropriate stimuli to cause the patient to produce a given nonsense or superfluous expression repeatedly without the intervention of long pauses until at least a large number of the stimuli for the superfluous act cease to call it forth. This results not in an absolute, but only in a relative forgetting of the undesired response. It was finally suggested that the fact of relative forgetting of the superfluous response is due to a dissociation of certain organic structures involved; that this dissociation is in turn a result of a simplification or purification of the structures; and that these phenomena can be consequently explained without assuming the annihilation or even the permanent exhaustion of any of the structures which function to produce the nonsense expression.

A PRELIMINARY REPORT ON 'WORK WITH KNOWLEDGE VERSUS WORK WITHOUT KNOWLEDGE OF RESULTS'

BY GEORGE F. ARPS

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The primary purpose of this study is to secure a quantitative statement of the influence of awareness as a factor in work.[1] To this end three sets of experiments were conducted by means of the Bergström ergograph. In each of the sets the observer at one time remains in comparative ignorance (complete so far as it is possible to make it so) of the amount and character of the work he is doing; at another time he is given every opportunity to observe his work as it proceeds and to study the results ad libitum. Each set of experiments is therefore divided into two series, designated 'unknown' and 'known' respectively. A series is made up of work periods.

The mental complexes, antecedent to the work response in the various series of experiments, are sufficiently diverse to prompt an inquiry concerning the meaning of this diversity in terms of work units.

Three observers, *M*, *J* and *W*, functioned in the experiments; in the case of *M*, experimentation continued over the greater part of three years. The method common to ergographic work prevailed. In our case the hand and arm of the observer were strapped into the machine in such a way as to secure maximum freedom for the middle finger (the work-finger of our experiments) of the right hand.

The instructions given each observer were simple. In the first work period he was instructed to pull the ergographic load on every beat of the metronome, sixty to the minute. This load was 4 kilograms for the first two sets of experiments

[1] The study will in no wise concern itself with the theoretical aspects of the controversial question of the relation of the psychical to the physical.

and 6 kilograms for the third set. The observer was repeatedly instructed to make each lift represent his maximal pull and to continue the lifting until he was no longer able to budge the load. The work period closed when the observer failed to move the load in two successive attempts. In the second work period, forty-eight hours later, the observer was instructed to lift the load for ten successive beats of the metronome and then to rest for one second (one beat) then to lift again for ten beats followed by another rest of one second. This process was repeated until the observer, as in the first work period, was unable to budge the load. The third work period of this series differed from that of the second in that the rest period was increased by one second (one beat). In each successive work period of this series the rest increased by one second. There are eleven work periods in each series. This procedure prevailed as well for the work periods in which the observer was relatively unaware of his accomplishments as for those periods during which he was fully aware. The procedure for any ascending series may be algebraically represented by the following formula:

$$\frac{P}{W + R_0}, \quad \frac{P}{W + R_1}, \quad \frac{P}{W + R_2}, \quad \cdots, \quad \frac{P}{W + R_{10}},$$

in which P represents ten ergographic lifts; $W + R_0$, a work period without rest; $W + R_1$, one second rest, etc., until the number of lifts and the number of rests are equal.

A 'set' of experiments is made up of (*a*) an ascending series of work periods in which the periods differ increasingly by one second of rest up to ten as a maximum, and (*b*) a descending series in which the periods differ decreasingly by one second until there are no rests. Graphically they may be represented as follows:

→ Ascending Series, Known.
Rests = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.
→ Ascending Series, Unknown.
→ Descending Series, Unknown.
Rests = 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0.
→ Descending Series, Known.

Care was taken to distribute as equitably as possible the effect of practice. The disadvantage, for example, accruing to the *known* in the ascending series of the first set was practically neutralized by beginning the second set of experiments with an *unknown* ascending series. Other advantages and disadvantages are similarly neutralized, as, for example, the disadvantage of the so-called phenomenon of 'breaks' which occurs between the conclusion of certain of the series and the beginning of certain other series. It will be seen from the above graphically represented series that the concluding work period of the ascending known series contains an equal number of ergographic pulls and rests. The beginning work period of the immediately succeeding series contains *no* rests. This transition from a work period containing ten rests in each of its subdivisions to a period containing no rests is termed a 'break.' Obviously it is important to distribute such breaks equally to the known and unknown series.

In the three sets of experiments there are six *unknown* and six *known* series, which together constitute 112 work periods. In the third set of experiments the number of work periods in each series is six. Each of these periods has an *absolute* and a *unit* efficiency value. Both values are explained under the tables given below.

Tables I. and II. set forth the two values of the twenty-two work periods of two of the series and other data which may serve in presenting a survey of this study.

Some of the important results are as follows:

1. The final average of the *absolute* efficiency values of all the known series of the first and second sets of experiments exceeds that of the unknown by .2 per cent.

2. The final average of the *unit* efficiency values of all the known series, excepting the third set of experiments, excels that of the unknown by 7 per cent. In the known work periods the observers work at a higher rate of speed.

3. The average absolute efficiency value of all the known series exceeds that of the unknown by 10 per cent.

4. The average absolute efficiency value of the known

series of the first and second set of experiments exceeds that of the corresponding unknown by 10 per cent.

5. The average absolute efficiency value of the known series of the third set of experiments exceeds that of the corresponding unknown by 10 per cent. (The ergograph load in this set is 6 kilograms.)

Tables I. and II.

First Ascending Known. Load 4 Kilograms (Observer *M*)

B	*C*		*I*	III		*C* + III		*D*	*W*	$\frac{W}{C}$	$\frac{W}{C+III}$	*MWJ*	*WP*
	Min.	Sec.		Min.	Sec.	Min.	Sec.						
1	1	57	0	0	0	1	57	1.665	6.66	.0569	.0569	.0595	.0595
12	1	53	1	0	11	2	4	2.073	8.29	.0733	.0669	.0805	.0737
11	1	46	2	0	20	2	6	2.330	9.32	.0879	.0740	.0878	.0735
12	1	56	3	0	33	2	29	2.276	9.10	.0785	.0610	.0854	.0338
21	3	37	4	1	24	5	1	4.877	19.51	.0899	.0649	.0828	.0605
24	3	59	5	1	55	5	54	5.710	22.84	.0954	.0646	.0883	.0614
23	3	49	6	2	12	6	1	5.447	21.79	.0949	.0603	.0859	.0549
32	5	16	7	3	37	8	53	6.144	24.57	.0776	.0461	.0789	.0481
32	5	27	8	4	8	9	35	8.482	33.93	.1008	.0589	.0908	.0627
54	8	59	9	7	57	16	56	13.921	55.68	.1003	.0548	.0917	.0497
55	9	17	10	9	0	18	17	13.693	54.77	.0985	.0500	.0917	.0465

First Ascending Unknown. Load 4 Kilograms

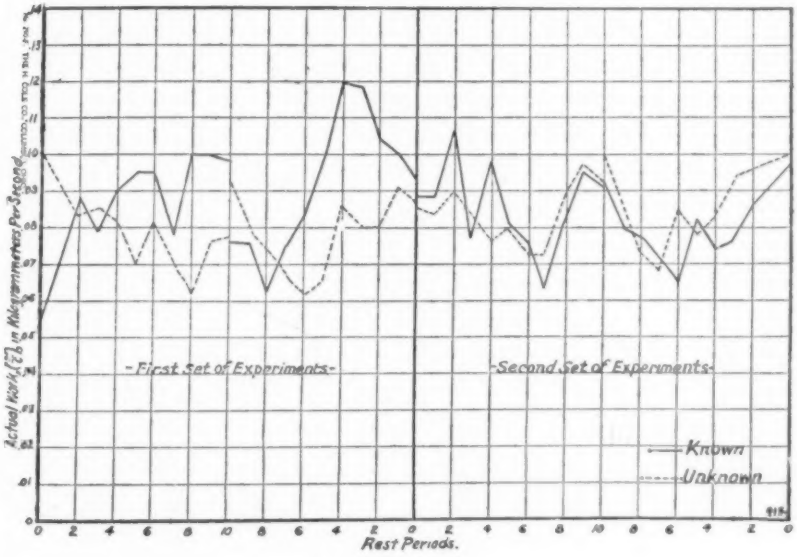
1	1	20	0	0	0	1	20	2.162	8.65	.1008	.1008	.0705	.0725
11	1	54	1	0	10	2	4	2.642	10.57	.0926	.0851	.0893	.0788
13	2	18	2	0	24	2	42	2.905	11.62	.0843	.0717	.0876	.0793
15	2	25	3	0	42	3	7	3.101	12.40	.0856	.0664	.0747	.0595
21	3	35	4	1	20	4	55	4.382	17.53	.0816	.0593	.0707	.0579
33	5	26	5	2	40	8	6	5.734	22.94	.0703	.0471	.0714	.0479
21	3	35	6	2	0	5	35	4.339	17.36	.0806	.0518	.0708	.0454
40	6	37	7	4	33	11	10	6.746	26.98	.0679	.0402	.0677	.0407
64	10	40	8	8	24	19	4	9.781	39.12	.0612	.0342	.0624	.0350
101	16	52	9	15	0	31	52	19.528	78.11	.0771	.0408	.0658	.0350
90	15	0	10	15	0	30	0	17.584	70.34	.0781	.0407	.0692	.0354

B = Number of subdivisions of work periods.
C = Total time at work.
I = Length of rest period in seconds and number of the period.
III = Total rest time.
C + III = Total time of work and rest.
D = Distance load travels in meters.
W = Work done in kilogram meters.
W/*C* = Unit value per second of work done each period.
$\frac{W}{C+III}$ = Rate of work including the rest time.
MWJ = Average unit value (*W*/*C*) of all observers.
WP = Average rate of work per second for each period including the rest time.

6. The average *unit* value of the known series of all sets of experiments shows a higher rate of work by 18 per cent. over the corresponding value of the unknown series.

7. The average *unit* value of the known series of the first and second sets of experiments shows a higher rate of work (speed) by 5 per cent. over its corresponding value of the unknown series.

8. The average *unit* value of the known series of the third set of experiments shows a higher rate of work by 35 per cent. over the corresponding value of the unknown series.



Involuntary Substitution of Imagery for Perceptual Contents

The curious appearance of imagery during the work periods of certain of the unknown series is an interesting phenomenon in that it clearly indicates the observer's tendency to avoid working blindly. The point of definite appearance of imagery may be seen by reference to the curve given above.

The relation of the unit values of the known and unknown second ascending series of the second set of experiments is

especially interesting in that the fact of overlapping of the curves is referred to the apparent functioning of imagination. From the introspections it appears that the condition of 'ignorance of results' prevailed more completely in the *first set* of experiments than in the *second set.*

The unknown series of work periods of the second set of experiments approach that of the known through the employment, without set purpose on the part of the observer, of visual and kinesthetic imagery reproductive of the perceptual and kinesthetic experiences of the work periods of the preceding known series. In the third work period of the second set of experiments (see curve), the following introspections are recorded: "The task of this period proceeded with a fair degree of definiteness, with a comfortable degree of orientation hardly comparable to any of the preceding unknown periods. Certain individual lifts I pictured vividly; in certain other cases I compared successive lifts. The comparisons were especially pronounced when the first evidence of fatigue appeared." In the sixth period of the same series the observer remarked that he "seemed to sense the efficiency of the entire period in perspective more or less tangibly."

Imagery is also involved in the more or less abrupt closing of the unknown period as contrasted with the gradual tapering off closing of the known periods. On this point one of the observers remarks as follows: "In closing an unknown period I seem to let down suddenly in spite of all efforts to avoid it. Short lifts have little meaning in that I fail to image the pen marks which support me in the long lifts."

In all these cases evidently imagery of the sort here described acts as an incentive to work. The presence of imagery was first detected in the first work period of the second unknown ascending series of the second set of experiments. It is probable that the overlapping of the curves of this set of experiments finds an explanation in the definite presence of imagery. For, as the imagery content of consciousness peculiar to the work periods of the unknown series approximates that of the perceptual content characteristic of the work periods of the known series, the differences in

the awareness of results diminish. It is probable that the more essential features of the perceptual experiences acquired in the first set of experiments function in imagination in the work periods of the unknown series of the second set of experiments. If the mental complex operative in the second set of experiments forms a close resemblance to that complex functioning in the first set, and, if the efficiency differences of the known and unknown work periods are primarily due to the degree of 'knowledge of results,' then we have an explanation for the crossing back and forth of those parts of the curve representing the unit values of the work periods of the second set of experiments. This means that we have here phases of the process of habituation in which the established habits of response under perceptual conditions tend to subordinate responses operating under imaginal conditions. That the organism tends to gravitate towards its more accustomed channels of behavior is clearly indicated in succeeding work periods. Each succeeding set of experiments shows an increasing amount of crossing of the 'unknown' and 'known' curves (see graph).

From the general character of the curves and the introspective statements it appears that work carried on under conditions of partial awareness of results loses in efficiency and that such conditions are extremely difficult, if not impossible, to maintain when such work is followed or preceded by, work of identical character under conditions of complete awareness. Without set purpose the observers employ certain mental complexes during work under the former conditions, which parallel in function certain essential features of the mental complexes operative during work under the latter conditions.

THE BEHAVIOR OF THE HUMAN INFANT DURING THE FIRST THIRTY DAYS OF LIFE[1]

BY MARGARET GRAY BLANTON

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In view of the fact that a large amount of experimental work is being done by the psychological laboratory upon the reflex and instinctive equipment of the babies in the maternity ward of the Johns Hopkins Hospital, it seemed worth while to make a preliminary observational study of them under the conditions actually obtaining in the nursery. Most of the studies now in the literature are of this character and the present one has also the object of checking up others of the same character. The present observations have been made upon a very large number of infants and a thoroughly objective viewpoint has been maintained throughout.

Buccopharyngeal

1. *Sneezing.*—The earliest reflex noted. It was present on one occasion while the infant was being lifted from the mother. Subject L. sneezed before the birth cry appeared, and Subject G. at 5 hours, from which time on it is common. It was frequently noted on taking the babies into an overheated room where observations were made. It was not noticeable on bringing them again into a cooler atmosphere.

Preyer[2] says: "It demonstrated the existence of a very firm connection, long hereditary, of the nasal branches of the trigeminus with the motor expiratory nerves." He also

[1] This work was undertaken under the direction of Professor John B. Watson, director of the psychological laboratory of Johns Hopkins University. Through the courtesy of Dr. J. Whitridge Williams and Dr. Daniel Davis, the material in the nursery of the maternity ward was placed at our disposal. I am also much indebted to Miss Liphart and to Drs. McKee, Harris, and Sperry for many privileges on the ward.

[2] Preyer, 'The Mind of the Child,' p. 214.

quotes Darwin as saying that many healthy children at their coming into the world do not cry, but sneeze.

2. *Hiccoughing.*—Subject Sp. at 6 hours hiccoughed for three minutes. Subjects 7, 10, 11, and 14 days old hiccoughed after feeding. This list might be continued, for over 50 cases were noted. It seems so well developed at 6 hours that there is little reason to believe that the possibility of it does not exist at birth did conditions call it out. The condition most commonly calling it out is a full stomach (producing pressure on the diaphragm).

3. *Yawning.*—I have noted yawning twice within 5 minutes after birth and relatively few times during the first month. Subject S. yawned at 5 hours, eyes tightly shut. Subject F., 11 days, yawned 6 times in 1 hour; her eyes were squeezed tight and her chin trembled as she shut her mouth. Subject R., 5 days, yawned so like a sigh that the movement barely fell within the definition of a yawn. It was the only occasion on which the remotest resemblance to a sigh was observed.

4. *The Beginning of Speech and Emotional Reactions.*—Crying, less than any other manifestation of a baby's existence, can be considered separately. During the birth processes the connection between the mother and infant are made less efficient by the gradual displacement of the placenta. The concentration of the blood increases, which stimulates the respiratory centers and causes the intake of air to the lungs. The birth cry takes place at this point. Occasionally the nerve endings of the mucous membrane, affected by the unaccustomed stimulation of the air, may cause a light breath to be taken in and expelled in what we know as a sneeze. In four observed cases in which hot and cold plunges were necessary to stimulate breathing there was also a sharp movement of the arms. The cry observed came on the plunge into icy water and was sharp and short and on an inspiration as in an adult under similar conditions. The birth cry is rarely spontaneous, as the technique of the delivery is to stimulate it at once by vigorous rubbing and slapping on the back and buttocks. This cry, as I observed

it, differed in no way in timbre, pitch, etc., from other cries of the first few days. The birth cries of different infants were not alike, ranging from simple *a* (as in at) to *u* (as in cut). Most of them were compound *u* (as in cut) followed by *wah* (as in at); *uh* (cut); *nga* (at); and variations just as in the later cries of infancy. This was true also of the three spontaneous cries which I heard.[1]

Major[2] says: "The beginnings of language are usually traced to the reflex crying of the newly born babe." Both Major and Preyer assert that "they are produced as well by a child without a cerebrum as a child with one." I was not present at the birth of Subject B., mentioned elsewhere, but I was told by the surgeon that this infant did not cry out. Only 4 cries were noted during its entire 10 days of life, all of them taking place during a deep examination to determine the extent of displacement of the bones of the skull. The birth cry which is followed by an interval of quiet is rarely followed by an interval of stillness.

Crying has been observed under the following conditions: (1) hunger; (2) in response to noxious stimuli (including rough handling, circumcision, lancing and care of boils, sores, etc.), and (3) possibly from fatigue or lack of exercise. In the subjects with which I worked I did not find the cries of hunger, to noxious stimuli, to fatigue, and so forth, uniform. There were differences of vowels and consonants, of timbre and degree, but no one was used as response to one set of circumstances that was not at some time used to others. For example the cry in response to noxious stimuli was in many cases an exaggeration of the cry usual when hunger was present.

The cry of colic was the one exception. Starting abruptly

[1] The dramatic element of the first cry has led to a most amusing amount of poetic license. Kant's famous saying that "the outcry that is heard from a child scarcely born has not the tone of lamentation but aroused wrath," has been subjected to many and various comments. Preyer in quoting him says, "Kant wrote without having himself observed children and animals just born." Dr. William A. White quotes Adler as saying: "It is an expression of its overwhelming sense of inferiority on thus suddenly being confronted by reality, without ever having had to deal with its problems."

[2] Major, 'First Steps in Mental Growth,' p. 282.

about 3 to 5 octaves above the adult female voice it slid through a modified chromatic scale to within the range of the middle octave. It was made with an accompanying rigidity of the abdominal walls and thus of necessity varied from the cry which included the activity of these muscles. Subject L., 15 days, often started with a few short rapid breaths, a few of which sounded like an 'affected' cough and ended with a two syllable cry, *a* (at), and *yow* (owl), long and on a falling inflection. The whole is much like the word *meow* with the *m* replaced by *a*. The cries did not vary so much with the ages of the infants, during the first five or six days, as with the weight. A baby of 2,300 grams at one day, and 2,300 grams at 5 days will show little difference. However, a baby of 4,000 grams first day and 4,000 grams fifth day would show more difference, probably because 4,000 grams weight would indicate a better physical condition. In such a large group of babies any vowel or consonant can at some time or other be heard on the first day of life that will be heard on any other day during the first month. *A* (what) will be heard in a first syllable, but I have not heard it in a second syllable excepting in a series of short grunts. This I suppose is because a maximum of activity is reached on the second syllable, and the maximum activity in the infant is accompanied with an open mouth and a contraction of those muscles which draw the inferior maxillary inward and downward. This, it is seen, precludes the making of the *ah* sound.

The crying of one baby can be distinguished with some practice from the cries of another even in a nursery of 25, the overtones varying just as in older people. Subject M., first day, *u* (cut), *nah* (at) accent on last syllable, *u* (cut), *wah* (at), *wuh* (cut), *ha* (at). The 'hunger cry' has generally a well marked rhythm, the first syllable of preliminary sound coming on the first part of the first beat, the second or accented syllable on the second part of the first beat and a quick intake of breath as the third beat. This measure is most often repeated in groups of 5 or 6, each slightly more forceful than the preceding ones until the fourth or fifth,

the last one being softer. Thus also will the groups be repeated. Each measure is also a trifle higher in pitch than the one preceding.

Sounds Heard during the First 30 Days.—Consonant sounds commonly heard are *m* in conjunction with *a* as *ma* (at), *n* as *nga* (nat), *g* as in *gah*, *h* as in *ha* (at), *w* in *wah* (at), *r* as in *rah* (at), *r* as in *burr*, very slight sound, and *y* as in *yah* (at).

Vowel sounds are *o* as in owl, *e* as in feel, *oo* as in pool, *a* as in an, and *a* as in father (relatively rare).

Of interest was the variety of animal cries simulated in the nursery. The 'pot-rack' of the quail, the cry of the goat, the whine of the young pig, and the wail of the wild cat, each had a close imitation.

Pelvic

5. *Erection of Penis.*—Subjects Le S. and R. had an approximate erection of 50° at birth, Subject F. 80°, and Subject Sch. at birth, a complete erection against the stomach wall. These babies were, of course, lying on their backs. Subject M. at 4 days, also lying on back, had complete erection.

6. *Voiding of Urine.*—This occurs at birth in about 30 per cent. of the male infants observed.

7. *Defecation.*—This of course occurs often before birth, as the condition of the amniotic fluid shows. It is also, possibly, an occasional cause of suffocation, which would seem to indicate that it occurs some time before birth. In Subjects S. and R. it was persistent and profuse immediately after birth. The passage is of course the usual meconium. If it does not occur then the usual time is from 18 to 24 hours. No norms were kept, however. When the temperature thermometer is pressed into the anus there is very often a resultant passage of feces. On five sets of observations the results were: (*a*) 7 positive, 8 negative, (*b*) 4 positive, 15 negative, (*c*) 13 positive, 11 negative, (*d*) 5 positive, 4 negative, (*e*) 8 positive, 16 negative, making out of 91 observations a *total* of 37 positive and 54 negative.

Ocular

8. *Eye-movements.*—While an inequality of eye-movements is not uncommon it is not the rule. Subject J., 5,600 gr. birth weight, often had a hint of 'cross-eyes.' At 25 days he occasionally had an unusual condition—his eyes being entirely open he would drop the balls in such a way as to show much more of the sclerotic coat above one pupil than the other. In other subjects, 6, 7, 10, 11 and 15 days of age, the sclerotic was noted as visible above the iris. Subject H., whose entire system of reflexes was markedly different (the one baby examined whose hands would not clasp on a small round rod), had peculiarly symmetrical use of his eyes, but his eyes were never seen to fixate the light nor to follow a hand moved in front of him. Subject W.'s eyes worked independently: starting to the left in unison the right eye would move more rapidly than the left, and starting to the right the left eye would move more rapidly than the right. A large percentage of the babies fixated on the light at birth. Subject S. continued to do so when removed to the side of the room. When we turned her head away she turned it back at once, bringing the light into her line of vision. She would also fixate on the figure of a person who interrupted the light. At 8 days of age she would gaze steadily at the electric light in the nursery, rolling her eyes up, when a change of position necessitated it, keeping the light in her line of vision. An interesting 'by-product' was the persistent paddling of her hands at such times and a recurrent spasmodic smile. Subject M. at birth gazed without blinking until her face was covered. Subject L., 34 days old, held by mistake in bright sunlight, first shut her eyes, then opened them, fixating directly on the sun. Her pupils contracted to the size of pin heads. At 30 days of age she would, when carried down the corridor, gaze at a high light on the painted wall, arching her back and finally throwing back her head as she was carried away. She would also, while holding her head still, follow the figure of the nurse around the room. At 32 days of age her eyes caught a red velvet bag held in bright sunlight, and followed it, with her head held still,

around the nearly complete half circle of her vision. The eyes of many of the infants followed a slowly moving hand a few moments after birth. Subject S. would follow a hand moved slowly 8 or 9 inches from her face without any accompanying movement of the head.

Subjects S., A., M., F., and J. gazed at the light above the birth bed and also followed a moving hand. Subjects F. and K., neither of whom gazed at light or followed hand at birth, were seen to do both on the 8th day. Subject K. at 8 days, Subject R. at 10, and Subject L. at 26 days focused first on one and then another face. Subject S., 13 days, fixated a large paper bag which was being handled. A dim light moved slowly at half a meter was followed by subjects 8 hours, 18 hours, 36 hours, and 3, 4, 5, 6, 14, 15, 21, and 30 days of age. Subjects which did not follow were aged 9 hours, 3, 5, and 14 days; 17 in all were tested.

Preyer observed in two cases, 11 and 13 days, a turning of the eyes from one bright light to another. Miss Shinn's niece[1] fixated her eyes on a face first at 25 days. Preyer, Rochlman, and Wilkowski observed 'real fixation' on the tenth day. Dearborn[2] notes seeing the eyes of a child 13 days old follow a slow-moving desk light at 18 inches, and says had he the courage of his convictions he should say he saw the baby's eyes follow a hand slowly on the first day. Preyer's baby followed a desk light at one meter at 23 days, much to his surprise, as he says "other children do not follow a moving light until after many months." According to him, however, Lacy saw this the second week and Darwin the 45th day—but a majority of investigators say the 5th, 6th and 7th days.

9. *Eyes during Nursing.*—These babies, as a rule, had their eyes open at the beginning of nursing. As they began to get enough food the eyes would close. Some babies, however, were most active after nursing.

The following observations were made:

[1] Shinn, Millicent, 'Notes on the Development of a Child,' Book No. 1, p. 30.
[2] Dearborn, G. V. N. 'Moto-Sensory Development.'

Subject O. K., 5 days old.....right eye open, left shut,
" H. 3 " " .....eyes partially closed,
" R. 7 " " .....near end of feeding, shut,
" W. 7 " " .....near end of feeding, shut,
" R. 14 " " .....both eyes open,

and subjects 4, 5, 5, 5, 9, 15, 20, 21, and 25 days old with eyes open. Miss Shinn[1] says: "I have watched and enquired about several other babies and found none that nursed with eyes open."

Facial

10. *Tears.*—On the testimony of Miss Liphart, Subject P. cried tears at birth. Subject C., whom I saw, had tears in her eyes at ten minutes after birth. As silver nitrate is administered as a routine measure some time during the first two hours, a reliable record of the activity of these glands was not obtainable. Subject B., birth weight 5,600 gr., at 4 days cried profusely with right eye. He was an overdue baby, breach delivery and with, consequently, no head moulding. Subject B., an exceedingly cross-eyed baby, cried tears on his 6th day. They were not observed in him again, however, in the remaining 4 days he was in the institution. Subject S. showed dampness in corner of eyes, uniformly, on the 13th day, Subject L. on the 15th, and crying with tears seemed well developed with her on the 34th day. The first average normal show of dampness was 13 to 16 days. The first regular flow of tears 28 to 34.

11. *Smiles.*—Spontaneous smiles at an early age are rare. Subject S., 4 days, smiled spontaneously while at the breast after feeding; Subject O'K., 7 days, at end of bottle feeding; Subject S., 13 days, while looking at bright light; Subject K., 8 days, smiled and immediately regurgitated; Subject C., 28 days, smiled repeatedly after feeding at the breast, but the first smile had followed a light touch of the mother's nipple on his cheek. Subjects 1, 2, 4, and 6 days old smiled slightly to a tickling touch under the chin when awake and comfortable.

12. *Facial Expression.*—According to Preyer, the corners of the mouth are not drawn down until the eighteenth week.

[1] Shinn, *op. cit.*, Book 1, p. 12.

He quotes Darwin as noting it in the 6th week to the 2d and 3d month. Subject M., 10 minutes, pulled the corners of her mouth down. Subject S., 30 minutes, rolled the lower lip so as to show the inside surface, pulled the corners of his mouth down, and after remaining in this typical pouting attitude for a minute started crying. Subject J. did this constantly as a preliminary to crying, sometimes accompanying it with a whimper-like grunt which made him seem remarkably mature. He had also the square box-shape mouth in crying, as had Subject L. on the 7th day and again on the 14th, 17th, and 23d days.

Subject G., 6 days, had a horizontal line directly across his nose from corner to corner of his eyes. In crying he would pull down the inner corners of his brows making wrinkles that radiated from the horizontal cross line. Subject C. at birth had the horizontal line between his eyes. Horizontal lines across the forehead are not exceptional when an infant looks up. It was seen in Subject M., 6 days, Subject P., 15, 19, 21, and Subject L., 7th day, and often thereafter.

Head

13. *Turning Head (when Lying on Face).*—The ability to turn the face (when the nose is firmly planted) in such a manner as to get air is a disputed point. Preyer[1] says: "Newborn children cannot so much as free the face by turning the head when one lays them on a pillow with face downward." In making the experiment I used a pillow only once, but as I had no way of ascertaining how hard the pillow was which Preyer had used I made my tests on the lap of a nurse and tallied each test on a hard table. In the one case of the pillow a female child of 3 days freed her face at once and held her head upright for several seconds. The tests made on lap and table did not differ in results nor did those on the birth bed. Subject C., 30 minutes old, rotated her head in such a way as to leave her mouth and nose free. Subject G., 1½ hours, Subject B., 1½ hours, and Subject M., 9 hours, could do equally well. On one occasion 15 healthy babies

[1] 'The Mind of the Child,' p. 266.

were tested and all were positive but one—Subject G., 8 days old, who lay until turned. Subject L., 8 days old, not only turned her head but raised it in the air also, entirely unsupported, and held it so for 30 seconds by stop-watch, when she was interrupted. At 15 days the same baby held her head so for 5 minutes. This test was repeated time and time again. Even the sickest babies could do it when the air supply was cut off.

14. *Holding Up the Head (when Held in Upright Position).*—Preyer[1] says: "During the first ten weeks no trace could be discovered, in the case of my boy, of an attempt to hold the head in equilibrium." "In this important step is expressed an unquestionable, vigorous act of will." There has been some confusion among the different writers, due I think to the fact that the exact test conditions were not given. In my tests the subjects were held on an open lap, not against the body, were supported back and front for two inches above the umbilicus. Subjects 2, 6, 7, 10, 10, 11, 13, 13, and 15 days old could support their heads for times varying from 1 to 6 seconds. Subject L., 22 days, held her head quite erect for 3 minutes, turning it from right to left. Subject F. made numerous attempts with only the shortest periods of success. Subject Y., 22 days old, badly underfed and weak, made no apparent effort. Subject W., 22 days old, child of retarded parents who is also weak and undernourished, failed likewise. Any weakness in the neck muscles must be in those which draw the head forward, as numerous and successful attempts were made on the ability to lift the head when laid on the face (see *turning head*, when lying on face).

Arm and Hand

15. *Hand Movements at Birth.*—Subject E. at birth spread his fingers and closed his hand, repeating this 4 consecutive times. Subject S. stretched his fingers with first joint of first, second and third fingers bent. This was with both hands at the same time.

16. *Grasping Reflex.*—Reflex closing of the hand to a

[1] 'The Mind of the Child,' p. 264.

touch on the palm has been noted a very few moments after birth as in the case of Subject C. who grasped the artery clamps which held his umbilical cord. It was seen in Subject K.'s gripping of the doctor's finger to the degree of slowing up the entire operation of caring for his umbilical cord. Experimentally of course the first step was putting a small rod into the hands of the infant to excite the reflex and then to lift the rod so that the full weight would be supported. My apparatus was a small skirt hanger with a rod about a quarter of an inch in diameter bound with a very thin wrapping of gauze. The prevailing custom of oiling a baby at birth was counteracted by giving the hands of the baby a good cleansing with alcohol. This reflex has been described as one which is most pronounced at birth and which diminishes rapidly afterwards. I have not found this to be so. For whereas a baby inside of the first few hours of life will cling 1 or 2 seconds, Subject Sm. on her 23d day, weighing 4,260 grams, held on for 20 seconds and was then laid down still gripping the rod. This reaction is very hard to elicit from a quiet baby, very easy from a crying one, and the crying when set up has the sound of what is called in the nursery an 'angry cry.'[1] Subject A., 20 hours old, clung 2 seconds and 10 seconds, Subject L., at 52 days, supported herself with one hand on the rod for 42 seconds.

Abnormalities either mental or physical affect this reaction less than any other. Subject B. clung tenaciously at 10 days even when life was practically extinct. He would grip a rod put into his hand so strongly that it was necessary to undo his fingers. Subject Q., 5 weeks old, dying of malnutrition, lifted his entire weight and only relaxed on being laid again on a solid support. An interesting by-product was the climbing movement of the legs occasionally noted. But these alternation movements of the legs are also the movements of kicking.

17. *Grasping during Nursing.*—Major found in his child that the finger clasp was firmest when the child was nursing.

[1] Robinson says in "Darwinism and the Nursery" that at the beginning he found that babies had grip and muscle power to sustain their own weight on a horizontal bar, and he adds the comment that they even delight in the process.

My examination of 15 babies before, during the beginning of, and after nursing did not seem conclusive. Subject W. gave definitely harder pulls at the breast, according to the mother, as the pull of my finger in his hand made him grip firmer. One subject's grip was better before nursing; 2 were the same all 3 times; 2 were the same before and during nursing, and poorer after; 1 was negative before and after and only very poor during nursing; 1 pulled only slightly during and after but had about the same grip on both occasions; 1 was definitely better during nursing and was absent after nursing; 4 were best during nursing; and 3 were best after nursing. No one baby was poorer during nursing than before or after, but as will be noted in 3 cases it was no better during nursing than at one of the other trials; and in 4 cases it was definitely poorer than on one of the other trials.

Leg and Foot

18. *Creeping.*—In one case (aged 7 days) there was a creeping movement in which a backward movement of six inches was accomplished in twenty minutes' time. By marking the position of the head at the beginning and end of the period the amount of movement was ascertained. On each occasion the contracting and relaxing seemed mainly of the abdominal and back muscles. The great hindrance to successful movement in each trial seemed to be the insufficiency of the muscles of the arm used to draw the arm from a position on a line parallel with the body to one at right angles to it. The legs often at any time after birth assume the crawling position. The head (see *turning head*) can be held up out of the way, but the relaxed position and relative weakness of the shoulder muscles make forward progress impossible. This condition lasts beyond the 30th day and certainly well into the 3d month, probably longer. An interesting accompaniment of this creeping movement is the opening of the mouth and the bumping of the head, set up, it seems to me, by the well-organized face and mouth reflexes. The accidental touching of cheek and chin to the unyielding surface of the table and his inability to get any

part of it into his mouth, seemed elements in the arousal of his crying.

19. *Foot Movements and Reflexes.*—Subject S., at birth, held the foot rigid, raised all 5 toes uniformly and pulled them down uniformly 4 times. The Babinski reflex was found present in 10 cases tested, and apparently absent in one. Subject S., when tickled on the center of her foot, drew the two outside edges towards each other. The statement is frequently made that babies can cling with their feet. I have never seen this. Placing a fine wire under the toes, a reflex movement downward caught the wire between the pads of fat on the toes and the ball of the palm, but the slightest pull would remove it.

20. *Kicking* and to a less extent moving of the arms is almost continuous for from 15 to 30 minutes after delivery, which period is commonly followed by a sleep of from 6 to 8 hours. The kicking was greatest on the side to which there had been a rotation of the head, this rotation apparently being decided by the position of the child in utero for the last period before birth. For instance Subject M., whose head rotation was to the right contrary to the usual rule, was a remarkably active child, and kicked excessively with her right leg and waved her right arm. Her reflex to the tying of the cord and to alcohol was however with the left side of the body. After delivery it was noted that she had a preferential side, which in this case was the left side, and this preference for the left continued for the term of observation. Her right-side activity immediately after birth might be explained by the cramp of the right side in utero and the relatively free position of the left.

General Responses

21. *Turning Over.*—Subject M. at 10 minutes after birth given a slight, unintentional advantage by the slanting of the mattress on which she lay, turned from her face to her back. Subject T., at 7 days, turned repeatedly from face to back when not impeded by clothing. Placed face downward on an unyielding surface her arms outstretched in line with

her body, she would immediately start crying. In crying, relaxing and contracting of the legs, arms, abdomen, and back muscles are natural accompaniments. Pulling her knees under her and contracting her muscles generally, she would, when relaxed, have her arms nearer by a fraction of an inch. In 10 minutes, after 9 repetitions of this general maneuver, her arms would be sufficiently near her side so that with a final contraction she would roll over.

22. *Reflex to Stimulation of Umbilical Cord.*—There was apparently a reflex to the clamping, cutting and tying of the umbilical cord. There is no direct nervous connection between this and the body. There are of course nerves in the opening surrounding the cord at the end where it is attached to the skin of the abdomen. The findings were not uniform. I should say that the deliveries which I witnessed were divided between three surgeons. Subject L.–1 straightened leg at clamping of cord with artery clamp. Subject L.–2 (twin to L.–1) same; Subject S. straightened leg to tying, not to clamping. Subject C. kicked at tying of cord, no reflex to clamping; Subject B. kicked lustily at tying at 1½ hours (I did not see clamping); Subject R., no reaction to clamp, positive to tying; Subject R., positive to tying; Subject S., positive to clamp only. Three babies kicked vigorously when clamping and tying were done; Subject F. and Subject M. were negative to both. The only explanation was that in clamping and tying there was some pulling and the reaction was from nerves lying next to the umbilical opening. One of the surgeons kindly undertook to hold the cord much laxer in all the operation than even the technique called for. There was no reaction to clamping but a distinct doubling up of the legs to the tight tying of the tape.

23. *To Dropping.*—The best example of this reaction was mentioned in the section on grasping. Watson and Morgan[1] have described dropping as a stimulus to fear as follows: "To suddenly remove from them all means of support, as

[1] 'Emotional Reaction and Psychological Experimentation,' by John B. Watson and J. J. B. Morgan, *Amer. J. Psychol.*, 1917.

when one drops them from the hand and allows them to be caught by the assistant, the child being held over a bed on which has been placed a feather pillow." Additional evidence of reaction to dropping appeared in the course of this study. On 3 occasions when the box in which newborn babies lay was suddenly lowered there was a marked movement of the arms and in one case brief holding of the breath. This same thing occurs repeatedly when the infants are being weighed. After the removal of a big weight the scale pan in which the infant lies may drop suddenly; the result in many cases was the same upward movement of the arms. In this case the jar of the pan hitting the support is to be taken into consideration.

24. *Stretching.*—This movement varies from the mere full raising of the arms and a complete stretching of the legs and toes, to arching of the back and abdomen and pushing the arms until they trembled, accompanied by the bending of the end flanges of the fingers. There was in one case a movement of the neck and pulling forward of the shoulders. The inferior maxillary was drawn inward and downward, giving a most adult cast to the countenance. Infants stretch with the greatest freedom at the removal of the clothing and especially at the removal of the diapers now in use. Subject L., 25 days, crying for a late feeding and very wet, was hushed at once by being held to the fire with feet uncovered. Here she stretched her legs into muscular combination after combination and finally juxtaposed the palms of her feet and went to sleep. She accompanied every marked change of position and tension of the muscles with an opening of the mouth, and each relaxing with a closing of it. Subject S. stretched on being put with a bright light in her line of vision. This was repeated 6 times, each time giving the same result.

25. *Response to Sound Stimuli.*—The reaction to sounds immediately after birth is unusual. Subject M., lying in a high-walled tin box, on a metal table, resting on tiles set in cement, reacted vigorously when one of the doctors in passing hit a metal stool, a foot or so away, with the heavy door. The

baby was covered with a blanket. The stool did not hit the table, and the only vibrations reaching him were through the tiled floor or through the usual air vibrations. He threw his arms forward forcibly enough to dislodge the covering, at the same time moving his entire body. It seems reasonable to conclude that his reaction was to sound. At two days this baby jumped similarly when a metal tray was hit with a fountain pen at a distance of one meter. The tray was held stationary. Three other subjects the same number of days old gave no response. Subject H., 6 days old, batted his eyes when metal disk was struck with a hammer behind his head. She responded thus the first two times, and the third time she did not respond. Subject H., 6 days old, and Subject T., 5 days old, were tested with tuning forks. The forks were struck and the boxes held opposite the ear of each baby when they were crying. There seemed to be a slight diminution in the crying each time. Subject L., also, at 7 days, seemed to be quieted by the big forks. Subject L., 20 days, and Subject H., 16 days, did not react to the Galton whistle at any pitch. Subject P., 29 days old, turned her face 5 times in the direction in which I was whistling softly—about half a meter from her head. There were several elements to be considered, however, as I was sitting on the side of her next an open fire, and, also, my breath may have touched her face. Her general movements, her expression, and the immediateness with which she turned each time as soon as I began whistling, incline me to believe that there was localization as well as auditory response. She was also seen to turn three times in the direction of the basin into which water had suddenly and forcibly been turned. Subject S., 13 days, as mentioned under eye-movements, turned at once in the direction of a heavy paper bag which was being folded. Her face was away from the bag, turned towards a mild fire, and her movement in turning was decisive, her eyes catching the bag unhesitatingly and holding it steadily. It was a very interesting example of the coordination of audition and vision. Repeated experiments showed that babies showing no reaction to other sounds would

react positively to these rattling paper bags. In 13 trials with subjects 4 to 14 days old, 12 were positive. Four were hushed in crying, 4 turned in the direction of the bag, and 2 in the opposite direction, but since the movement of body and eyes was markedly different to what it was when the experiment started, those turning away were considered as giving a positive reaction. Subject B., on the second day, would jump at a whistle or the sudden sound of a voice on the far side of the room. The sudden dropping of the scales, 6 feet away, would cause marked convulsive movements. This condition persisted until about the 4th day, when his response gradually became less marked, until on the 7th he would not respond at all.

Response to Noxious Stimuli

26. *To Deep Pricking of Big Toe.*—For laboratory purposes it was necessary to draw blood from 3 babies at 2 times. Two of the babies were pricked 2 times on the left big toe, one once on the left and once on the right. At each time the other foot went up at once with a pushing motion against the other ankle. As this motion is also one of the motions of kicking no conclusion could be drawn. There was no pronounced cry but one of them was crying when taken up, and all were given, between the two operations, a lifting test which always elicits crying.

27. *To Lancing of Infected Finger.*—Subject Le S., crying with hunger, had to undergo the lancing of a badly swollen and infected finger. It was necessary also to hold the arms firmly, which very uniformly has the effect of making the subjects cry. His cry during the lancing and cleaning of the finger continued to be of the same character, but much exaggerated.

28. *Circumcision.*—Unfortunately the time selected for circumcision was immediately before a feeding. The element of hunger had therefore to be taken into consideration as well as that of pain. A small gauze sponge dipped in whiskey and sugar or wine and sugar was given the baby by the Hebrew physician who performed the operation. The

crying seemed loudest while preparation was being made, stopped slightly at handling of the penis, began again at manipulation of the foreskin, and was slightly accelerated after the cutting. The babies were in every case quiet during the ceremony which followed, but this was insured by the amount of alcohol administered.

Response to Dermal Stimuli

29. *To Prick on Wrist.*—On one occasion I tested 21 sleeping infants by lightly pricking the wrist. I attempted to use the same pressure on the pin each time, making it just hard enough so that when tried on my own wrist it aroused a pain response. Thirteen gave a movement of the hand or forearm in response to the pin touch and 8 did not respond. Subjects giving positive results were 2, 2, 2, 3, 6, 7, 8, 8, 8, 16, 17, 17, 19 days old. Those giving negative were 2, 2, 3, 6, 6, 8, 9, and 26. As an interesting note on the experiment it is worth mentioning that of the 8 giving no response 6 were the children of either one or two defective parents.

30. *To Being Rubbed.*—The cleaning of the newborn with oil affords a most interesting opportunity for the observation of dermal and deep pressure reactions. The rubbing of the head, and especially the rubbing of the back, brings out the most active reactions which in all probability the baby will be called on to make in the first month of life. The screaming which invariably ensued was of such a volume as is hardly attained in the first 6 weeks under ordinary conditions. During the scrubbing of the head 15 of the babies which I saw delivered impeded the progress of the operator to a greater or less degree by a constant moving of the hands. Subject K. caught the hands of the operator through the whole of the cleaning process. Since the vernix caseosa is most heavily deposited on the back, rubbing the back brings out a response of the lustiest crying, and in 3 cases, when the infant was supported by the left hand of the surgeon in a crawling position with hands and knees touching the bed, crawling movements were elicited. In neither of these cases of course is the stimulus entirely dermal,

since a good deal of pressure is exerted on the muscles and deeper structure; and certainly the squeezing of the body as well as the pressure on the unattached skull bones undoubtedly introduced kinæsthetic factors. The cry elicited is identical with the 'angry cry' of the nursery and is in fact so called by a great many operators and nurses.

Subject F., 13 days, raised her right arm at each of seven strokes of her nose, but did not approach the hand to the nose. Subject S., at 30 minutes, moved both hands to her nose when it was held, but on the second trial moved them in the opposite direction.

31. *To Dampness.*—Immediately after the voiding of urine the napkin has a higher temperature than usual. After a certain length of time the wet diaper becomes colder than usual. When the element of temperature is eliminated there is little evidence to show that babies up to 6 weeks show any particular response to wetness or dryness of their diapers. In a nursery in which there were 16 wet babies, 10 were quiet and 6 crying. A few minutes after changing, 10 were crying and 6 were quiet. Substantially the same results were obtained in another group of 19 infants. In the course of these observations enough cases have been investigated to show that it is extremely difficult to predict whether a baby is wet or dry because of its cry. There are nursery saws to the effect that babies 'cry because they are wet' and are still 'because they are dry.' Rounds of the nursery will often show that neither conclusion is justified, as babies under 30 days void frequently, and out of a nursery of 25, 15 to 20 wet babies can be found at any time within 30 minutes of changing. It is not uncommon to have them void immediately on changing, stimulated perhaps by the coolness of the fresh diaper. Subjects 4, 6, 10, and 14 days old were on one occasion crying and wet, but the diapers were quite cold to the touch as well, and subjects 4, 5, 9, 11, and 21 were wet and quiet and the diapers seemed about body temperature.

32. *To Warmth and Cool.*—Preyer[1] says: "Sensibility to

[1] 'The Mind of the Child,' p. 183.

contact is, in the first hour of life, much inferior to what it is later; the sense of temperature does not exist." I have noted 6 occasions on which there was marked shivering within 15 minutes of birth, on two occasions it persisted until the infant had been brought near to a hot water bottle for some time. The skin of this baby was cold to the touch. The shivering was so pronounced as to make a marked movement of the toothless lower jaw which under other conditions we call 'chattering.' The reaction to warmth during the second day of life was marked. Uncovering the lower part of the infant's body to the heat of a mild fire caused curling of the toes both upward and downward. Subject L., 7 days, when she had been some time with the outside of her right leg next a rather hot fire, crossed it over her left and thus away from the fire. Subject S., at 9 days, when placed in a warm tub, moved her arms outward and downward, palms backward, elbows straightened, and on the forward movement, bent—much as in swimming. She opened her mouth wide, with her tongue over the surface of her lower lip; her breathing became noisy and accelerated, the air being forced out of her nose in what might be called a snort.

33. *Alcohol.*—An excellent test of the reaction to cold of the skin of the very young was offered by the application of alcohol dressings to the stump of the umbilical cord. The surgeons delivering obligingly dropped small amounts where I indicated. When dropped on the lower half of the abdomen kicking resulted uniformly; dropped on the lower left part of the abdomen the left leg would respond; on the lower right, right leg; lower center, both legs or either right or left. Above the umbilicus the reaction was not so certain but when obtained was a movement of the legs.

Response to Kinæsthetic Stimuli

34. *Kinæsthetic Sense.*—Dearborn[1] says: "It is one of the anomalies of psychology and of physiology, that kinæsthesia, most basal and important of the senses, has been so

[1] 'Moto-sensory Development,' p. 1.

relatively neglected. Without it no infant could become more humanly efficient than a plant." This sense is probably the earliest of all developed, coming as may reasonably be supposed before kicking does in the fourth or fifth months of life in utero. Miss Shinn[1] refers, under Rhythm, to the 'superior quieting influence of a monotonous jarring as compared with a smooth motion.' Experiments on placing infants to the breast to quiet them were made as early as the third day of life, and as the amount of milk gotten up to that time is negligible it is fair to assume that changes in the position or pressure was the cause of the resulting quiet. Walking with the babies quieted them as early as the first day. Ten subjects under 4 days responded by ceasing to cry. One of these was crying with every symptom of abdominal pain. It was noted that babies crying in the corridor were exceedingly rare and the approximate number of trips daily through the corridor with infants was 120. Of the many dozens of trips made to and from the laboratory only one child was known to cry the entire distance; one cried the first third of the way and was quieted. Subjects at 6 hours, 18 hours, 1, 3, 3, 4, 6, 6, 7, 7, 9, 11, 14, and 18 days who were crying in their cribs were quieted by lifting and gentle pressure. Subjects at 10 hours, 4, 6, and 9 days were quieted by pressing the infant's body between the hands. Subjects 1, 3, and 6 days were quieted by pressure on chest. Subjects at 6, 8, and 10 days were quieted by firm pressure around head.

Reflexes Connected with Feeding

35. *Cheek and Chin.*—This test was a light touch on either cheek in a straight line parallel with the mouth and about an inch removed from the corners, and a light touch on the chin exactly above the center. The subjects giving a positive reaction moved their mouth in the direction of the touch. Subject M., 5 hours, positive; Subjects Mon., $5\frac{1}{2}$ hours, K., at 7 hours, H., at $8\frac{1}{2}$, and D., at 9 hours, were all positive. Subject F. at 9 hours was positive to right cheek, negative

[1] Note book II., Miss Milicent Shinn.

(did not react to touch) on left cheek and chin. Subject B. (microcephalic in dying condition), 10 days, positive to right cheek and negative to left and chin. Two hours later Subject H. (positive in above list) gave a complete negative when in a very deep sleep. After feeding this reaction is hard to elicit. During hunger it is easy and the infant often moves with surprising quickness, catching the testing finger in its mouth. One infant giving a positive reaction at 5 hours showed a complete negative at 7. Inquiry showed that through a mistake in routine the baby had been put to the breast in the interim.

36. *Lip Reflex (Thompson's).*[1]—This is gotten by tapping lightly with the tip of the finger below or above the corner of the mouth of a sleeping baby. The result is a closing and pouting of the lips into a nursing position. Tests were made on 14 sleeping babies an hour before feeding. The most marked result was Subject R., 7 days, who pursed his lips, protruded the tip of his tongue between them and sucked it vigorously. Subjects 16 hours, 4, 5, 7, 9, 10, 11, 19, and 21 days old pursed the lips and protruded the tongue but did not suckle. Subject M., 9 days, pulled his head back quite markedly and rolled out his under lip. There was no suggestion of pursed lips or suckling. Two subjects at 10 days jerked the head slightly but gave no other response. Subject Y. at 19 days gave no reaction. This baby was markedly malformed and the child of retarded parents.

37. *Tongue Reflexes,* at birth and later. Movements similar to the movements and position of the tongue and lips in the lip reflex (Thompson) may be seen immediately after birth. These movements which appear to be merely unrelated and random are related to suckling. The tongue protrudes from the mouth and the edges are curled upward and over in such a way as to make the partial vacuum essential to sucking, much easier than if the back part of the tongue, only, was depended on. The use of the muscles in the back of the mouth apparently requires a higher type

[1] Thompson, John, 'On the Lip-reflex of Newborn Children,' *Rev. of Neurology and Psychiatry*, Vol. I., 1903, p. 145.

of coördination (see suckling and swallowing below). The forming of the tongue into this protruding tube can be seen in infants up to 30 days, at the time of feeding. If the food is removed before satiety is reached there is often an active sucking of the protruded tongue.

38. *Sucking Fingers.*—This seems to vary mainly with the manner in which the fingers are gotten into the mouth. Subject M. at 20 minutes put his thumb directly into his mouth and began sucking it. Subject S. during the first 2 hours of life put his right first finger into his mouth 6 times. His action was not fumbling. He touched his face either below or above his mouth, which set up the sucking reflex noted under lip reflexes (36) and the finger was pulled directly into the mouth. Once the sucking had been started there was rarely any fumbling. Three exceptions to this rule also showed weak swallowing reflexes and each of them had either one or two retarded parents. Subject S., child of imbecile mother and retarded father, attempted for 15 minutes to get her finger in her mouth, but did not succeed. These babies' mouth reflexes are given more fully under swallowing and suckling below. Subject G., a 'blue baby' two hours old, put his fingers directly into his mouth. Subject D., 2 days old, Cæsarian delivery, very feeble, was seen sucking two fingers so vigorously that it required a decided effort to remove them. She put them back in at once without trouble. She was also seen with all 4 fingers in her mouth. Subject B., a mal-formed baby mentioned elsewhere, 10 days old, in dying condition, put his finger in his mouth after 4 trials. Both his sucking and swallowing reflexes were moderately good. The former were better than the latter.

39. *Suckling and Swallowing.*—A demonstration of the presence of the ability to suckle immediately after birth was attended by many practical difficulties on account of the sterile operating field surrounding the subject. A sterile nipple was supplied at each delivery and the surgeons very kindly held them in the babies' mouths. As the process of obtaining sterile nipples became difficult on account of some

local conditions the expedient was devised by one of the surgeons of cleansing his gloved hand in sterile water and letting the baby suck his finger. Subject S., immediately after spontaneous cry, was given the nipple. The reflex faintly present was perceived as a slight movement of the lips as in sucking, and as a swallowing movement in the throat. Subject O'K., aged 23 minutes, suckled slightly. Subject Sc., very blue, and with umbilical cord around neck at birth, at 10 minutes sucked well, at 25 minutes sucked so violently that it was necessary to hold the unattached nipple with an artery clamp. Subject Le. S. sucked definitely but not vigorously at 15 minutes. Subject M., 6 minutes, sucked vigorously and at 30 minutes sucked very hard. Subject R. sucked vigorously at 10 minutes. Subject S. sucked definitely at 13 minutes and vigorously at 25. This list continues with little variation through the whole series. Occasionally it was not practicable to get the trial immediately after birth, but in no case did the baby refuse definitely to suckle during the first hour of life. Nothing but the most marked retardation or injury seems to affect this reflex. Swallowing, with sucking, tongue, lip and cheek reflexes go to make up the feeding reflex. The evidence is strongly in favor of the fact that weakness in the ability to swallow is at least suggestive of mental retardation whereas sucking is present at birth in most infants. Interesting in connection with this is the fact that certain forms of retardation which are accompanied by speech defects show a lack of coördination in the same muscles which seem defective in swallowing—namely, the control of the soft palate and back part of the tongue and throat. Going back over this list, Subject S. was the child of healthy and mentally well developed parents. Both her swallowing and sucking reflexes were good. She was dismissed at the end of 10 days and was considered excellent in every way.[1] Subject O'K., child of intelligent parents, dismissed in 14 days, rated excellent. Subject Sc. sucked violently at nipple but did not swallow well and was not

[1] A discharge was not given these patients until the best possible feeding habits had been established.

dismissed until 21 days old with a rating of moderately good. Her mother was a high-grade moron. Subject L., whose mother was graded as 12 years by the Binet-Simon intelligence test, was dismissed at 18 days. This infant's swallowing reflexes were very poor. Subject M., child of mother rated as 10 years mental age and who also showed a marked tendency to certain psychopathic conditions, fed moderately well, but at 2 months is not thriving as well as at 2 weeks. Subject R. (child of deaf and dumb primipara of 32, who, on account of her deafness, was not given a mental test, but whose practical ability for learning was poor and who showed a marked tendency to cruelty to her baby) left at the end of 3 weeks, her swallowing still faulty, with a grading of poor. Subject S. whose sucking at birth was vigorous enough left at the end of 3 weeks without having learned to swallow at all. The only food that this baby obtained was that which went down when it was carefully moved in such a way as to assist gravity. This baby sucked actively but ineffectually with his lips. At 2 months he was little more than a skeleton and could not swallow. The mother of this child was a low-grade imbecile who could not even put on her own clothing and who had to be fed with a dull-edged spoon. Subject P. (not on the list above) who possessed the sucking reflex, but in whom the habit of regurgitation was most marked, had an intelligent mother but the father was cruel, a drunkard and an habitual deserter, who had never been able to finish the lower grades at school. Twin babies K., whose mother's mental age was 10, had to be fed with 'Boston' feeders which push the milk into the mouth. It was exceedingly hard to get them to swallow. Subject K. remained in the hospital 2 months. He was the child of incestuous relations, the mother a low-grade imbecile and the father the same. In this baby even the sucking reflexes were absent and tube feeding was necessary. At 4 months he was just alive. Subjects W., Y., and K., whose swallowing reflexes were exceedingly weak, had each been in the hospital more than the usual time. Each regurgitated constantly. The mothers of these three did not exceed 10 years mental age.

Of value, in this connection, will be a study of the eating and speech habits of older children of retarded mentality.

Social Behavior

40. As the subjects were often found crying in groups, observation was made to determine social influence as an element. Note was made of each baby that cried whether in a group or singly through a number of hunger periods. There were 28 in groups of two or more, and 35 who cried singly. In observation I., two babies were kept together in a quiet room, and both slept. In observation II., Subject W., 10 days, slept. Subject Sm., 7 days, cried 20 out of the 60 minutes. Finding nursery conditions not under control, graphophone records were made of Subject L. when crying with hunger. These records were then played for 6 infants from 1 to 14 days of age. The results were negative. In observation IX., Subject L., 8 days old, and Subject W., 9 days old, were placed on a couch so that the conditions would resemble the nursery with regard to vibrations. Subject W. cried but Subject L. remained quiet, and later Subject L. cried and Subject W. remained quiet (and awake). Observation X., Subject M., 7 days old, quiet and awake (during graphophone record) made some suckling movements with mouth and tongue and his breathing became a trifle irregular—but afterwards, in an interval of quiet he made the same movements. Result negative. Observation XI., a final trial was made: smoked drum records of breathing were taken on several infants while the phonograph crying record was being run through. The resulting breathing curves differed in no way from those made of breathing in a quiet dark room. Conclusion: there seems to be no positive evidence of social influence of this character on babies under 15 days of age.

Summary of Results

In summing up the observations it will be seen that the reflex and instinctive equipment of the child at birth is more complex and advanced than has hitherto been thought. This

discrepancy is due perhaps to the rarity of the opportunity for unrelated persons other than nurses or physicians to observe during this period.

During the first twenty minutes of life may be observed sneezing, yawning, tears, sucking at nipple, fixating on light, putting thumb in mouth, jumping to loud sounds, grasping, crying with box-shaped mouth, crying with the corners of the mouth pulled down, following a moving hand with the eyes, turning of the head in such a way as to get air when placed on the face, turning over when given a very slight advantage, complete erection of penis, and most indicative, perhaps, the cry of so-called anger immediately after birth, justifying perhaps Kant's oft denied statement that the cry of a child just born has not the tone of lamentation but of aroused wrath.

The responses of the child, under twenty-four hours, to pressure and the completeness and effectiveness of the food reflexes as well as the value of the response to kinæsthetic stimuli to this complex of food reflexes are most interesting, and the possibility of a direct relation between the intelligence of the parent and the swallowing ability of the child hinted at in topic 39 suggests a field for further research which would be of direct value to those interested in the development of speech.

INDEX OF REFLEXES (Topic Numbers)

Alcohol (33); Arm and Hand (15, 16, and 17).

Buccopharyngeal (1, 2, 3, and 4).

Cheek and Chin (35); Circumcision (28); Creeping (18).

Dampness, to (31); Deep pricking of big toe (26); Defecation (7); Dermal Stimuli, response to (29, 30, 31, 32, 33); Dropping, to (23).

Eye movements (8); Eyes during nursing (9).

Facial (10, 11, and 12); Facial expression (12); Feeding, reflexes connected with (35, 36, 37, 38, and 39); Foot movements and reflexes (19).

General responses (21, 22, 23, and 24); Grasping during nursing (17); Grasping reflex (16).

Hand movements at birth (15); Head (13 and 14); Hiccoughing (2); Holding up head when held in upright position (14).

Kicking (20); Kinæsthetic Stimuli, response to (34).

Lancing of infected finger, to (27); Leg and foot (18, 19, and 20); Lip reflex (Thompson's) (36).

Noxious Stimuli, response to (26, 27, and 28).

Ocular (8 and 9).

Pelvic (5, 6, and 7); Penis, the erection of (5); Prick on wrist, to (29).

Rubbed, to being (30).

Smiles (11); Sneezing (1); Social behavior (40); Sound stimuli, response to (25); Speech and emotional reactions, the beginning of (4); Stretching (24); Sucking fingers (38); Suckling and swallowing (39).

Tears (10); Tongue reflexes (37); Turning head, when lying on face (13); Turning over (21).

Umbilical cord, reflex to stimulation of (22).

Voiding of urine (6).

Warmth and cool (32).

Yawning (3).

DISCUSSION

A CRITIQUE OF THE YERKES-BRIDGES-HARDWICK COMPARISON OF THE BINET-SIMON AND POINT SCALES[1]

The readers of this journal are doubtless well enough acquainted with the Yerkes-Bridges Point Scale to make unnecessary an extended descriptive account. It consists of twenty tests, nineteen of which are selected or adapted from the Binet-Simon series, but arranged, like the 1905 Binet series, in general order of difficulty, without being grouped by ages. The score is given by points, so many points being allowed for success in each test or part of test. Much emphasis is laid on the fact that degrees of success in meeting the several tests are distinguished, and some credit given for lesser degrees of success, as distinguished from the so-called 'all or none' procedure of the Binet-Simon Scale. The highest score which can be obtained is 100. The score of any individual is to be interpreted by comparison with a norm which has been determined by the examination of a group of individuals of the same sex, race and social level. Further details will be commented on in connection with the comparison between this scale and the Binet-Simon Scale.

Since the justification of the Point Scale rests confessedly on a criticism of the Binet-Simon Scale, and since this criticism is severe, and if it is accepted, must cause the abandonment of the Binet-Simon Scale, it is worth while to consider this criticism in detail and follow out the comparison of the two scales.

The criticisms of the Binet-Simon Scale are by implication statements of advantages of the Point Scale, and the advantages of the Point Scale are by implication faults in the Binet-Simon Scale; hence we may bring under the same head the disadvantages of the one and the advantages of the other. They make the following long list:

1. *The Binet-Simon Scale falsely assumes that the mental development of all individuals proceeds by similar stages.*

[1] 'A Point Scale for Measuring Mental Ability,' by Robert M. Yerkes, James W. Bridges and Rose S. Hardwick. Baltimore, Warwick and York. 1915.

There has been a good deal of criticism of the Binet-Simon Scale on the score of the assumptions which the critics find to underlie it. The authors of the Binet-Simon Scale do not tell us that these assumptions are involved, and even if some such assumptions as are laid down do seem to be involved it is most natural to regard them as working assumptions and the scale as a working instrument rather than a highly precise and accurate engine to apply a precisely known law. It is perhaps no exaggeration to say that the Binet-Simon Scale and the results of its application has given us more information regarding the actual course of intellectual development than all the other testing of children put together.

But take the assumptions themselves. Must not any scale which uses age norms make some such assumption as is indicated in the first criticism? The very purpose of the scale is to measure the deviation of an individual from a norm, and if there is no norm the deviation has no significance. As a matter of fact, the Point Scale makes this assumption in exactly the same degree as does the Binet-Simon Scale.

2. *The Binet-Simon Scale falsely assumes that the correlation between different functions is the same for all individuals at a given stage.*

If no flexibility in scoring were allowed in the Binet-Simon Scale the second objection would have some force, for there would then be no opportunity to make up for a deficiency in one mental function by unusual performance in another; but the possibility of gaining advanced credits at least in part overcomes this objection. Besides, the probability is that the correlation in rapidity of development of the different functions is fairly close.

3. *The Binet-Simon Scale falsely assumes that each stage of mental development corresponds in turn to a certain physical age, and that there is a 'correlation between the different functions at different stages of development.'*

Since any norm must be based on physical age, unless the age principle is entirely excluded by finding functions which do not develop with age, it does not seem possible to avoid the third assumption—that is, the first part of it. The second part of the statement is not amplified and the writer is not able to tell what it means.

4. *The Binet-Simon Scale falsely assumes that the mental development of the Paris school children follows the above-mentioned course of development.*

The fourth assumption is not fundamental to the scale, but only to its first form. It can be obviated, and has been obviated by revision.

5. *As a consequence of these false assumptions the Binet-Simon Scale employs the erroneous principle of age grouping of tests.*

It follows from the above statements that the age grouping of tests is not a fundamental point of difference between the Binet-Simon Scale and the Point Scale, since both scales involve the age principle, but that it is only one of the possible devices by which the age principle may be applied. The Binet-Simon Scale uses the age principle in the classification of the tests, and the Point Scale uses it in the construction of the norm. The issue is purely one of convenience. If many norms are needed it is easier to have them independent of the classification of the tests. Otherwise not. This question we shall discuss in a moment.

6. *As a further consequence of the age grouping the Binet-Simon Scale employs the crude all-or-none method of scoring.*

Considerable emphasis is laid on the distinction between the all-or-none scoring of the Binet-Simon Scale and the partial scores of the Point Scale. Here again the issue is not fundamental, and the Binet-Simon not only can, but does use the device of partial scoring by including several grades of difficulty of the same test and putting them at different ages. This is done, for example, with memory, interpretation of pictures, and weight discrimination. The same type of organization could easily be extended without in the slightest degree altering the general structure of the scale. In passing it may be remarked that the Point Scale in its present form assumes that the weighting of the various tests which it adopts is correct without giving it an experimental basis.

7. *Because of the age grouping of tests the Binet-Simon Scale cannot make due allowance for different rates of development due to sex, race and social or educational advantages.*

The bearing of the seventh objection depends on the interpretation which is made of the degree or basis of the sex, racial or social differences. If these differences require different norms the point scale method furnishes an easier device than the age grouping method. But if sex, race and social level all are factors which necessitate separate norms, the task, as we shall see in a moment, is a very considerable one. Let us first ask concerning the necessity. It seems to the writer that, instead of a case being made out for the necessity of sex norms, the results of the application of the

Point Scale indicate that no distinction of any clear sort can be made out. The lines which represent the scores cross and recross, and the crossing points in the English-speaking group are different from those of the non-English-speaking group. The race comparison which is reported brought entirely negative results, so far as total scores are concerned. Even if marked race differences had been found, the question might at least be raised whether it does not suit the practical purpose of an intelligence scale better to measure different race groups, at least within the same community, by a single norm than by separate norms. For classification in the school it would seem certainly better; and if feeble-mindedness is conceived in functional terms it would seem better for the selection of feeble-minded individuals also. With reference to social groups the chief question is whether the differences are inherent or the product of environment. If inherent, no separate norm is needed; otherwise it is. The probability is that the differences are at least in part inherent. In so far as they are not, the application of different norms would be exceedingly difficult. How many groups would be distinguished, what would be the basis of the distinction, how would a particular child be placed in the proper group, etc.?

Let us assume that we do have norms for sex, race and social level, as the authors propose, and that we have scales for the four types of mental function. A short calculation will show that the number of norms that would be necessary is sufficient to daunt the hardiest investigator. If we provide for three races only, and for three social levels, no less than seventy-two norms would be necessary. We start with four scales. The sex distinction necessitates eight, the racial distinction twenty-four and the social distinction seventy-two. The derivation of these norms would require the examination of at least seventy-two thousand children.

8. *Since in the Binet-Simon Scale 'later and more difficult tests have no more weight in making up the score than do earlier and easier ones, the same mental age may correspond to records far from equivalent'* (p. 33).

The feature which is criticized in the eighth article is given as one of the chief advantages of the Point Scale. It certainly is true of that scale, and is the direct opposite of the characteristic which is criticized in the second article.

9. *In its present form the Binet-Simon Scale does not give uniform opportunity to the various mental functions at different levels.*

The ninth article is similar to the second, and does hold true of the original Binet-Simon Scale, but is not essential to it.

10. *The Point Scale, as contrasted with the Binet-Simon Scale, is capable of giving results of ever-increasing reliability and precision as data accumulate and norms are established.*

Theoretically, the tenth point is well taken. Practically, the establishment of a norm is not a very extensive process, after the choice of tests has been made, and for practical purposes it is desirable not to defer the establishment of a norm too long. It is probable, for example, that the present Point Scale norm will be used for some time, since ideal programs are frequently long deferred in realization.

11. *There is less influence of the personal equation of the examiner in using the Point Scale.*

If the examiner has a constant bias in the direction either of undue conservatism or liberality in scoring the child's responses it is clear that the error is greater the larger the units which are represented in each judgment, and the larger the number of judgments which are made. A judgment which determined a large share in the child's rating would, if in error, cause a greater displacement of his rank than one which had a small share in his rating. Thus the breaking up of the Binet tests into subsidiary tests in the Point Scale, by making each unit smaller, reduces the error which is due to constant bias in either direction on the part of the examiner. As was pointed out in discussing the all-or-none method of scoring, this difficulty can be overcome in the Binet scheme by breaking up the tests and placing the constituent parts at different appropriate ages. The size of each error being determined by the value of the unit upon which it is based, the size of the total error will be determined by the number of the individual errors. An error can occur only in the case of those tests in which the judgment of the examiner varies from the true judgment. In the Binet Scale the range of such tests is confined to those of a few ages immediately adjacent to the child's mental age. In the Point Scale, because of the partial credit system and the scoring by points, the range of tests from which the child's score is made up is much greater. Hence the number of judgments which are factors in his rating is relatively larger. For this reason there are more opportunities for error which will affect the score. It would appear from these considerations that theoretically—and thus far we have no other basis for judgment—there is one respect in

which the Point Scale offers less opportunity for error on account of a constant bias on the part of the examiner, and one in which the Binet Scale, even as at present constituted, offers less opportunity for error. If this (admittedly hazardous) reasoning is correct the situation is about a 'stand-off.'

12. *The Point Scale 'works with a smaller amount of testing material, and thus makes possible a better choice of the same.'*

The twelfth point is not self-evident, particularly since the program of the Point Scale calls for the multiplication of the present number of tests four fold.

13. *The Binet-Simon Scale cannot—and by implication the Point Scale can—diagnose moral imbecility, dementia and intellectual degeneration, and occasional phenomena of degeneracy such as impulsions, obsessions and delirium.*

The present Point Scale cannot diagnose moral imbecility, etc., any better than can the Binet-Simon Scale, and no proposals are made which promise to make such diagnosis possible.

14. *The statistical results of the application of the Binet-Simon Scale are unsatisfactory, and a comparison of the results of the examination of the same 100 cases by the two scales are favorable to the Point Scale.*

The comparison of the statistical results of the application of the two scales to the same 100 children do not seem to the writer to be conclusive. In the first place, these 100 children were part of the group the examination of whom formed the basis of the Point Scale norms, and their Point Scale ratings were to some degree tested by a comparison with themselves. Furthermore, the mode of selection of the cases is not stated, and when the two ratings do not agree we have no means of knowing which is more nearly right. They are apparently not random selections, since only one individual is rated as normal by each scale.

15. *The Point Scale can be developed so as to give differential rating in the different kinds of mental processes, namely, receptivity, imagination, affectivity and thought.*

The development of differential scales is highly desirable, but the essential problem concerning it is the selection of tests, and when this is done they can be arranged either on the age principle or on the point scale principle, after the manner of the present scales.

This review does not attempt to pass judgment on the comparative merits of the two scales, but only to criticize the comparison which is made by the authors of the Point Scale. If this

criticism is drastic it is not more so than the criticism of the Binet-Simon Scale on which it comments. These comments may be summarized in the statement that the criticisms of the Binet-Simon Scale, which are made by the authors of the Point Scale are for the most part not essential and may be obviated by revision, or are equally applicable to the Point Scale itself.

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